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HYDRAULIC CANAL LIFT.

WE publish a perspective view of the lift erected at La Louviere, on the Canal du Centre, in Belgium, showing one ram raised and the other at the low level. The height of the lift is 50 ft. 6 in.; the length of the boxes between the gates is 141 ft. 7 in.; the width of each box, 18 ft. 4 in.; the depth of water in the box, 8 ft. 6 in.; the diameter of the rams, 6 ft. 6¾ in.; the weight to be lifted, 1,100 tons, and the displacement of the largest boat to be accommodated, 400 tons. The hydraulic cylinders are each formed of nine lengths of cast iron, hooped continuously with steel. The rams are 63 ft. 11 in. long, and are formed of eight sections of cast iron, 7 ft. long and 2·95 in. thick. The lift is operated by filling the box at the upper level to a greater depth with water than at the bottom level, this extra weight serving to overcome the friction and to compensate for the difference of weight of the rams in air and water. At the ends of the box there are provided grooves in which slide rising metallic doors, having their edges covered with India rubber. The ends of the box and of the fixed waterway are similarly equipped. The gates of the box and of the canal, which come face to face, can be fixed together by a locking apparatus. They are then lifted by means of chains worked by a hydraulic press. To form a tight joint between the moving box and the fixed end of the canal there are employed metallic U-shaped pieces with converging faces covered with India rubber. These keys being forced between the dressed faces of the flanges which form the ends of the box and the canal, produce a tight joint.

The lift was constructed by the Societe Cockerill, of Seraing.—*Engineering.*

HYDRAULIC LIFT AT LA LOUVIERE, CANAL DU CENTRE, BELGIUM.

A WELL VENTILATED MINE.*

By LEWIS STOCKETT, Member of the Engineers' Club of St. Louis.

THE ventilation of a mine is such a simple matter that I have often thought its very simplicity was one of the great reasons why it is so often neglected, and that if it was a more complex subject, requiring great learning generally and deep study locally, those who have the matter in charge would be more apt to give it the proper attention that it deserves. The ventilation of a mine consists in passing a current of pure air of sufficient volume through the mine and around the working faces to so dilute all gases, etc., given off as to render them harmless, and, mixing in with the air current, be passed out of the mine. This is the whole secret of mine ventilation, and to carry it out, it is first necessary to have the means of making the air current and then, this having been secured, to see that it is properly carried through the mine to the face of workings and wherever needed.

In order to pass an air current through it is necessary that a mine have at least two openings, one for an inlet and the other for an outlet. The current is produced by the difference in density and consequent difference in weight of the air in these two openings. This difference is made by various means, among which are the furnace, steam jet, waterfall, steam coil, and mechanical ventilators; it is also produced to some extent by the warmer, lighter air of the mine being pressed out by the colder, heavier air of the atmosphere (in warm weather the action being reversed), producing natural ventilation. Of these the furnace and mechanical ventilators are the ones most in use at present, and the most effective, and in this country the centrifugal ventilator commonly known as the fan is most generally used, for the reason that few of our mine openings are of sufficient depth to make the furnace the more effective.

The difference in pressure of the air in the inlet and outlet necessary to produce a current is so little that it can only be readily measured by the water gauge, which will show the pressure by the difference in height of two columns of water, connected together at the bottom, the upper end of one column being introduced into the air current and the upper end of the other open to the atmosphere. A difference of one to two inches, or from 5·2 pounds to 10·4 pounds per square foot, is sufficient, if the air shaft and air courses are of sufficient size to pass the current and the fan of sufficient size to allow the current to get through it.

Fans are of two general types, the vacuum and plenum, or exhaust and pressure blower, and of each of these types there are almost innumerable forms of construction, as there should be to meet the different duties to be performed in different localities. Of the two general types, the plenum or pressure blower is the more effective; this can be proved by a mathematical demonstration and corroborated by actual experience.

By whatever means the air current is produced, it is worthless if not properly distributed and carried without loss to where it is needed. This is where the greatest number of failures in ventilation are found, the superintendent, mining engineer, or any one in charge considering their duty done in having provided the means of creating the air current, and entirely neglecting to see that it is properly taken care of after secured. To properly conduct the current through the mine, it is necessary that the mine be opened with that object in view, remembering that an air current, requires a return as well as an intake. This is best accomplished by driving all entries in pairs and frequently cross-cutting. If the ventilation of the mine requires such a volume of air as to make the velocity so great as to be an inconvenience to those working therein, three entries should be driven, and by using one as the inlet and two as the outlet (or *vice versa*), the velocity on the two entries will be about one-half, and on these two entries the work of the mine should be carried on, using the other for an air course alone. This can also be accomplished when there are several districts in a mine by taking a split or portion of the current into each district and not passing the full current around through the whole mine, which will also have the important effect of increasing the amount of air by decreasing the total amount of friction and the velocity at which it travels.

In splitting the air into separate currents, care must be taken that this is not carried to an extreme, and the volume of each current so reduced as to be unable to perform the work required of it.

In passing the air up one entry and down the other of a pair of entries, the frequent cross cuttings alluded to above are a great source of loss of air through leaks in the stoppings put up in these cross cuts to throw the air on to the last one opened. It is frequently found that where the air current is more than sufficient at the mouth of the entries, at the face where it is most needed it was very weak or had entirely disappeared. Little leaks all along the line, trifling in themselves, but disastrous as a total, were the cause; and where the workings of one district hole through into those of another district is generally found a source of waste. To prevent this every cross cut should be closed as soon as the one ahead is opened by an air-tight stopping, which can only be securely and permanently done by being built of rock or brick laid up in lime and sand or cement mortar, and these occasionally plastered over. And to prevent the leaks from one district to another, where workings have holed through, rooms, breasts, stopes, etc., should be closed up as soon as finished and which will also prevent the gases from old workings escaping into and vitiating the air current.

Doors, curtains, regulators, and brattices are used to direct the air current and throw it where it is needed, as to the face of headings, up through working rooms, etc., and when used for this purpose only are very useful in their way. Main air currents should never be separated by a door if it is at all possible to do otherwise; overcasts in the top or undercasts in the bottom, either of timber, rock, or brick, are much better, and while the first cost is in excess, the wages of a door tender or trapper saved soon make them the cheaper.

* Read May 16, 1888.—*From the Journal of the Association of Engineering Societies.*

If for local reasons overcasts or undercasts are impossible, and the door must be used, two doors sufficiently far apart that in passing through them one can be closed before the other is opened, will prevent the loss of air from the opening of the door and reduce the amount of leakage.

Where the hoisting shaft is one of the openings for ventilation, the air current is considerably checked by the cages moving up and down in the shaft; where large hoists are made, it takes but little calculation to show that fully one-half of the time of working hours the cages are in the shaft and form a barrier to the air current at the time it is most needed. For this reason a separate compartment in shaft or another opening is essential. When the entries in the mine are small in area, a trip of loaded cars, if moving against the current or more slowly than and with the current, form a very serious barrier to the air, and in mines ventilated by only one main current almost stop the flow; to overcome this, whenever possible, the entries or headings should be driven larger than is simply required for the roadway. When the current is in several splits, this blocking of the air by trips of cars is not so serious a matter, for if one split be blocked it will increase the volume in another, and it rarely happens that all are blocked at the same moment.

The value of compressed air as a ventilator is made much of by those interested in introducing mining machinery to be driven by compressed air, but when we consider that it is a very large sized compressor that compresses 5,000 cu. ft. of free air per minute, and that this small amount is scattered in very small parts all over the mine and is used irregularly, we can put this factor down for nothing as regards the ventilation of the mine, and as less than nothing if it leads one to suppose that it is ventilating his mine and causes him to neglect other means of ventilation.

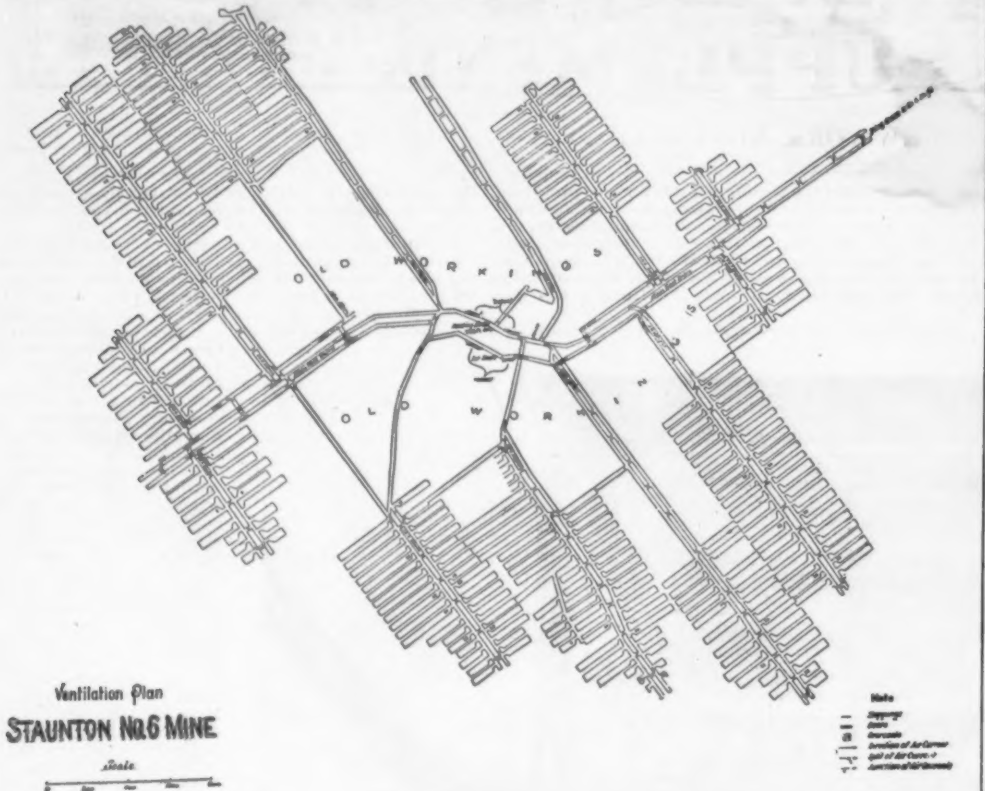
In a dry, dusty mine, where the air is constantly filled with floating particles of dust, explosions are likely to and have taken place from the ignition of the same from an overcharged blast or the firing of some small body of gas. With a proper air current these particles will be carried off, but in some cases it is only overcome by sprinkling the roads with water from water cars. These cars are arranged with a pump driven by a crank on the axle of the wheels, which will throw water through a hose and enable the top, sides, and that part of the bottom distant from the road to be wet down.

Having thus covered the ground somewhat generally, it is part of this paper to present a practical illustration of a mine where the details of thorough ventilation have been well carried out, show the mode of so doing, and give the results obtained.

The mine in question is known as Mine No. 6, and is situated on the Wabash, St. Louis & Pacific Railway, near Staunton, Macoupin Co., Ill. The current is produced by a 20 feet in diameter centrifugal ventilator, located at the head of an air shaft 5′ × 8′, and driven by an engine whose cylinder is 18″ × 42″, connected to the fan by a belt. The fan makes one and one-half revolutions to one of the engine; the usual speed is 60 for the engine and 90 for the fan; some idea of this speed can be had when it is known that at 90 revolutions the end of the blades are traveling 5,654 feet—over a mile—a minute, and exceeding the speed of the fastest railroad train.

The fan is so built that it can be readily and quickly changed from an exhaust to a pressure blower, and is so constructed that in all its relations it is equal whichever way it is used. The accompanying drawings will explain this.

The air current is divided into nine separate splits, the volume of each split being regulated to the amount of work being done in each district. This reduces the friction, the great destroyer of an air current, to a minimum, thereby increasing the amount of the air passing, and also reduces the velocity on hauling roads so that a naked lamp can be carried with ease.



Ventilation Plan
STAUNTON No. 6 MINE

Overcasts and undercasts are used wherever they can be to advantage, there being seven in number, and their location is shown by the accompanying map.

The stoppings between main and return currents are mostly of brick and lime and sand mortar, or built up of rock from the roof plastered over.

Old workings have been completely stopped off by brick and mortar stoppings, and the large amount of black damp given off from old gobs kept out of the current. Air courses were not used, as hauling roads have been cleaned up and the area enlarged to pass the current readily without excessive friction.

Further improvements in contemplation and under way are the driving of a main air course to another mine, to make use of an abandoned shaft for the second opening, and overcome the obstruction of the cages in the shaft before spoken of, and enable the escapement ladders and platforms in air shaft to be removed. These ladders and platforms in the air shaft are a very serious obstruction to the air current, and account for the high water gauge. After these are removed there will be a larger volume of air at the same expenditure of power, or an equal volume at a less expenditure.

The fan running at 90 revolutions as a pressure blower gives a water gauge of $2\frac{1}{10}$ inches, and at the same number of revolutions as an exhaust gives $1\frac{8}{10}$ inches, which will bear out the statement before made that the pressure blower is the more effective as compared with the exhaust fan.

As a pressure blower the fan running free to the open air gave a water gauge of $\frac{2}{10}$ of an inch and a volume of 240,000′ of air. With the outlet blocked up the water gauge was $2\frac{5}{10}$ inches or 13 pounds to the square foot for the pressure blower, and $2\frac{1}{10}$ inches for the exhaust fan.

With the fan running at 86 revolutions the following measurements of the volume of the air were made:

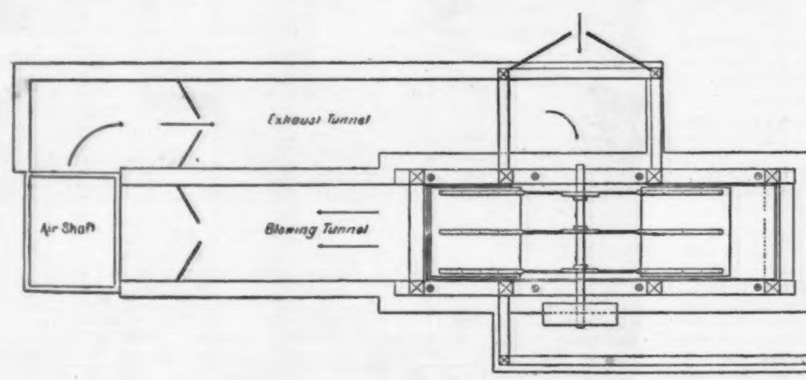
	Feet.	Feet.
Amount of air under fan........		76,636
" " " E. main split.......	35,100	
" " " W. " "	40,920	76,020
" " " E. return..........	36,450	
" " " W. "	44,250	80,700
" " " E. No. 1 split....	12,870	
" " " " " 2 "	6,875	
" " " " " 3 "	10,800	
" " " " " 4 "	4,320	34,865
" " " W. No. 1 "	6,000	
" " " " " 2 "	11,550	
" " " " " 3 "	10,125	
" " " " " 4 "	8,482	
" " " " " 5 "	1,692	37,849

The figures, while good of themselves, will be greatly increased when the improvements named above are finished and the job complete.

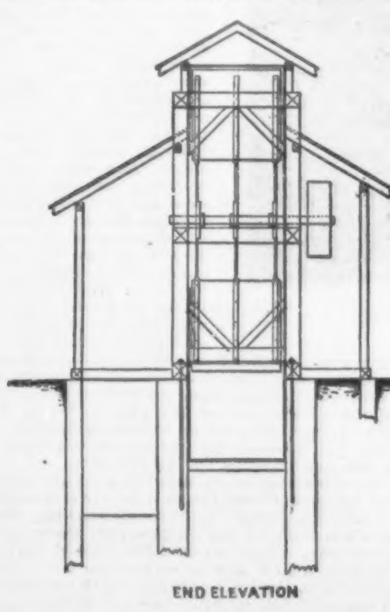
APPARATUS FOR MINING AND BLASTING UNDER WATER ON THE PANAMA CANAL.

THE curious arrangement of which we are about to give a brief description is located at the working point situated between kilometers 4 and 5 of the Panama Canal, at Mindi, near Colon.

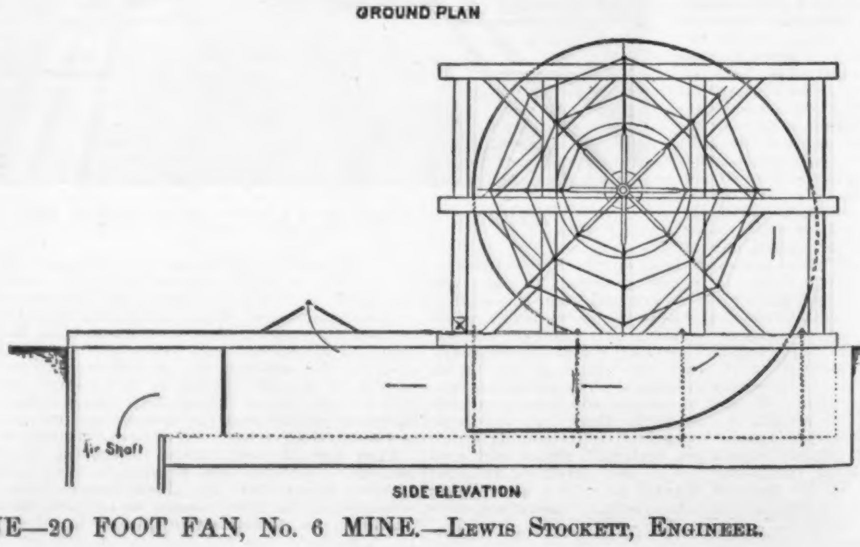
Here some rocky hills were met with that were cut down, by the ordinary methods of excavation, to the mean level of the sea. To about ten feet beneath this level, a portion of the excavating was done in dry soil and the material drawn out by pumps. The rest, com-



GROUND PLAN



END ELEVATION



SIDE ELEVATION

A WELL VENTILATED MINE—20 FOOT FAN, No. 6 MINE.—LEWIS STOCKETT, ENGINEER.

prising the extreme parts of the place of operations, was operated upon by three dredges, to the same depth.

Under such circumstances, it is evident that the preparation of the earth to be dredged was easy, since, for a thickness of 10 or 12 feet, the mining was done upon a platform whose height protected it against the water.

But, after the first operation of dredging had been performed, it became a question of effecting true subaqueous blasting.

To this effect the contractors constructed the apparatus described below, which is remarkable for its power and simplicity.

It consists of a raft composed of a wooden frame having the form of a rectangle of 80 × 46 ft.

This frame, which is made stiff by a cross bracing of transverse and longitudinal pieces, is supported on the water by 48 floats, of the kind used for supporting floating pipes.

The raft or frame thus arranged is covered with planking, in which there are three apertures, 8 in. square and 8 ft. apart, designed to give passage to the drilling tools.

The dimensions of the raft and the arrangement of the apertures permit of mining the entire width of the bottom of the canal.

In order to mine to the level —9, and, at the same time, to avoid fatiguing the miners, and to secure a proper amount of work for them, there have been selected iron pipes 1·4 inch in diameter and 15 ft. in length, that can be connected end to end, as in a water pipe, by means of a screw, and to the ends of these is affixed a drill.

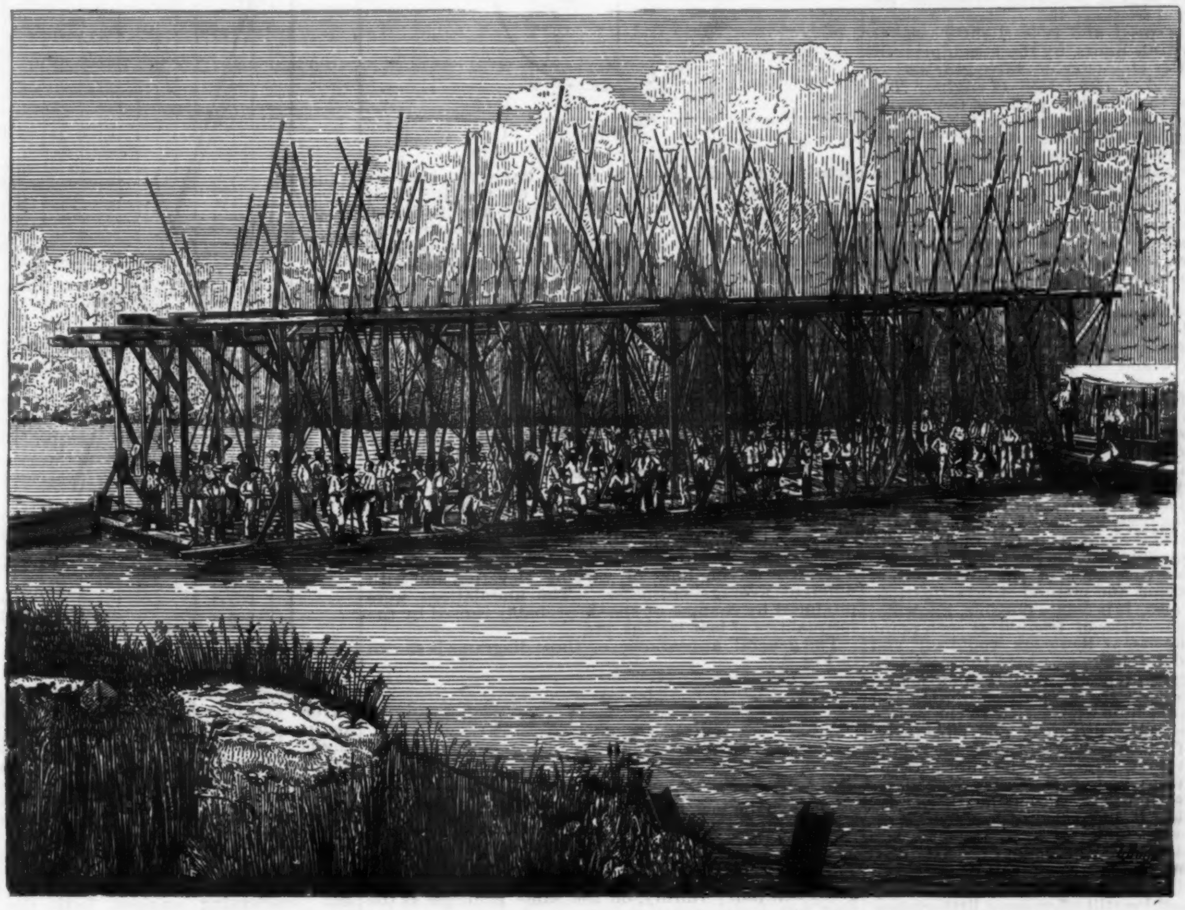
In this way, boring tools are obtained that can be increased or diminished in length. To maintain the tools in a vertical position, a superstructure has been erected on the frame that forms a sort of lattice-work roof, and through the interspaces of this are passed the drills, which are thus guided and held when they are lifted from the hole.

In order that the mine hole may not be lost when the drill is removed from it, there is provided an iron pipe of 4 in. diameter, which rests upon the rock to be mined, and which is held at the upper part by the aperture in the floor of the raft.

This pipe serves at the same time to guide the tool. After the hole has been charged, the pipe is removed by means of a pulley fixed to the superstructure.

The explosive is put in place by means of a pipe of 2·4 in. internal diameter. The different charges are connected by wires that communicate with an electric apparatus, and in this way from 30 to 40 charges are exploded at once.

The raft is kept in place by four anchors fixed in the banks of the canal. The chains are tautened by means of four hand windlasses.—*Le Genie Civil.*



APPARATUS FOR MINING AND BLASTING UNDER WATER ON THE PANAMA CANAL.

ON THE DISTRIBUTION OF INTERNAL FRICTION OF ENGINES.*

By ROBERT H. THURSTON, Ithaca, New York, Member of the Society.

INTRODUCTION.

IN earlier papers, read at various times before the American Society of Mechanical Engineers, the writer has called attention to the fact that the variation of load in steam engines is not productive either of the method or of the amount of engine friction that has been commonly assumed by earlier authorities on that subject.* It was shown that the formula of De Pambour, which makes the internal friction of the engine proportional to the load on its piston, is not usually correct, and probably is never so, with any familiar form of engine, or under any conditions often met with in practice. It was further shown that, under any conditions of usual practice, and at all ordinary speeds and pressures of steam, the resistance of the engine itself, its internal friction, remains sensibly constant, and that the so-called friction card of the machine represents practically the friction of the engine when fully loaded, the indicated power without load being sensibly the measure of the wasted work of the engine when in operation under load of whatever amount.

The literature of this branch of the subject of steam engineering is very meager, and the results of experiment in this field, if any have yet been systematically made, are not recorded in any works as yet consulted by the writer. The very natural supposition that the friction of an engine is always composed of two parts, the one the friction of the engine unloaded, a constant, and the other a quantity measuring the added friction due to the imposition of the load, and variable directly with that added load, seems to have been accepted by all writers from De Pambour, the first to attempt to consider the subject, to the period of investigation by the writer. On the other hand, however, engineers familiar with the operation of the engine have been accustomed to take a diagram with the steam engine indicator, the engine being unloaded, as representative of the friction of the machine at all times.

This was probably taken as so representative simply because it was usually impossible to obtain any measure of friction of loaded engine, and the friction card was thus the best approximation that could be secured. Rankine, would seem to have suspected that the assumed formulas of De Pambour might not be exact, as he remarks, "Our knowledge of the amount of energy so lost is still very vague and indefinite;" but he also states (Steam Engine, art. 292) that "in most cases which occur in practice, a result nearly agreeing with that of the preceding formula is obtained by supposing that the whole of the prejudicial resistance is proportional to the useful load." De Pambour gives the value of the coefficient by which the load is multiplied as about 0·14, and Rankine asserts this to agree with practice. Weisbach attempts to produce a formula for this waste, assuming Morin's values of coefficients of friction, but his results are very greatly in excess of those to be given as determined by investigations made to ascertain its amount by experiment; they also seem to be based upon entirely inaccurate assumptions, and are evidently quite as unreliable as are those of De Pambour and Rankine.

The first investigation undertaken systematically to determine the law and the methods of waste by internal friction in the steam engine were, so far as yet known, those directed by the writer, the scheme being the securing of constant conditions, except in the one direction in which variation was to be produced, for the purpose of noting the extent and the law of variation of friction with variation of the one element studied. Thus: The engine was placed under the usual and standard working conditions, but without load, and a friction diagram was taken as a measure of the power wasted in friction of engine alone. The conditions being kept constant in all other respects, the load on the engine was varied from this minimum up to and beyond the maximum rated power of the machine, and the indicated compared with the dynamometric power in every case, the difference measuring the engine friction for that power and load. In other cases, the speed of the engine varied, the power and all other conditions being kept constant; the same method applied when the power, speed, steam pressure, and other conditions were held constant, except that the method of distribution of steam was varied, and the results of such a series of tests were then compared with those otherwise obtained. In still other instances the steam pressure was made the variable element, or the ratio of expansion and point of cut-off, the indicated and dynamometric power being in each case compared as before to obtain a measure of the engine friction.

By this systematic method it was anticipated that in time a correct theory and exact formulas might be produced. This expectation has not been wholly disappointed; but the results of the investigation, while eminently satisfactory, have proved to be quite opposed to the original assumptions of the older writers, and in most perfect accord with those of the practitioners.

The first of these series of experiments to be made in so satisfactory a manner as to justify publication were those conducted under the supervision of the writer, in the winter and spring of 1883–84, by Messrs. Aldrich and Mitchell, and published in a paper read before the American Society of Mechanical Engineers in the autumn of 1884.* The engine employed was a straight line engine, constructed under the eye of its inventor, Professor John E. Sweet, past president of the society, and representing well that type of engine. These experiments showed unmistakably the error of the older formulas, and revealed the unexpected fact that, in that class of engines at least, the internal friction does not vary with the addition of load, but remains constant, so far as could be detected, at all loads. The method of lubrication and its efficiency, the variations of steam pressure and of speed, slight as they were, were accidental causes of change of engine friction, having very much greater effect on the total than a variation of the power of the engine from that marking its resistance to motion, unloaded, up to the full rated power of the machine, and even far beyond the latter amount. The engine had been carefully designed with the special intent to make engine friction as low as possible, and the loss by friction at its rated power was but about six per cent. It came down to about five per cent. at the maximum power demanded of it, varying almost precisely in inverse proportion to the indicated power. The "friction card" was a measure of the friction of the engine at all loads.

This research was again undertaken at the request of the writer, in the winter and spring of 1885, by Messrs. Day and Riley, of Sibley College, Cornell University, employing a similar engine, built under the supervision of the inventor in the workshops at that school. The outcome of these investigations, which have also been recently fully reported and widely published in this country and in Europe, was thoroughly corroboratory of the previous conclusions. No measurable variation of the total internal friction of the engine could be traced to the variation of engine power and load. Studying the effect of variation of steam pressure, it was found that some slight alteration was produced, the friction increasing very slowly as pressures were increased, but not in any important degree. These data have been since revised by Messrs. Carpenter and Preston, and it has been found that the change of friction with variation of steam pressure may be taken as

* Presented at the eighteenth meeting, Scranton, 1888, American Society of Mechanical Engineers. Advance sheets from Vol. x. Transactions.

* Friction of Non-condensing Engines. Trans., Vol. viii., No. ccxxviii., and Vol. ix., No. cclxv.

* Trans. A. S. M. E., Vol. viii., page 86.

insensible after passing the ordinary minimum working pressure of engines, the variation being observable only from about 50 or 60 pounds per square inch downward. It having been also suggested that the method of steam distribution might produce some change in the law exhibited by the types of engine having automatic adjustment of expansion by the action of the governor, Messrs. Gillis and Buchanan, in 1887, undertook, under the direction of the writer, to settle this question by experiments upon the engines of similar type, as employed in the mechanical laboratories of the Sibley College. These experiments fully confirmed those which had previously been made, and showed sensibly constant friction at all powers and loads, whether the engine was regulated by the automatic system or by a governor operating the throttle valve in the steam pipe or at the steam chest.

We are now brought to the study of the latest, and as yet unpublished, experiments made to determine, with some degree of exactitude, the *method of distribution of internal friction*, and, further, to ascertain whether all engines are subject to the same law as has been found to control the high speed engines previously employed in these researches. These last investigations were made with this object in view by Prof. R. C. Carpenter, of Lansing, Mich., and Mr. G. B. Preston, of Sibley College, as observers, experimenting first with the engines of the college laboratories, and later with other machines of various types in and near Lansing. Earlier experiments had shown the engine friction to be independent of the load, but to be a function of the characteristics of the engine itself, of the speed of piston and rotation, of the steam pressure, and of the method of steam distribution, the two last named conditions having slight effect, the others being most important. The weight and design, and the character of the workmanship of the engine, primarily determine the amount of its internal friction; the resistance is also a direct function of its speed, and it is slightly and observably affected, within limits, by the steam pressure variations and by the character of valve gear and of steam distribution and of regulation of engine. The speed and weight of the running parts of the engine may, so far as can now be ascertained, be taken as the elements controlling friction of the machine. The details of all this earlier work have been given at sufficient length in the earlier volumes of the Transactions of the American Society of Mechanical Engineers.

It now becomes an interesting and a vitally important problem to determine just how this friction of engine is distributed among its various moving parts, its journals and guides, stuffing boxes and piston rings. This has hitherto been regarded as a problem incapable of solution, since it was presumed that the total and the elements of the internal friction of engine would be so seriously variable with the alteration of load that it would be impossible to measure the friction of the machine part by part, and to sum up the whole correctly.

It having been found, however, that the internal friction of the engine is invariable in any measurable or important degree with variation of power, and that the so-called "friction card" is a measure of the friction of the engine at all powers, the speed being constant, it is at once evident that we may now proceed to analyze the several parts of this total by analyzing the engine into its various friction-producing elements, and measuring up the several elements of the total friction, each by itself, and summing all for the total. The discovery of the sensible constancy of the total friction thus affords a new means and method of investigation. This accomplished, also, it becomes possible, knowing, as we now do, the quantities of friction at each point of "pairing" of elements, as Reuleaux would say, and it becomes easy to determine just where the most serious wastes of energy and power are met, and thence, just in what direction we are to study the design and construction of the machine with a view to the reduction of these wastes most promptly and effectively. The improvement of the efficiency of the steam engine is to be now effected very largely by its improvement as a piece of mechanism; and nearing, as we now are, the limit of the perfectibility of the engine thermodynamically, the engineer is compelled to look in this direction for further opportunity of advancement. The thermodynamic efficiency of the engine has attained, in the best of modern engines, very nearly its maximum under familiar working conditions; the efficiency of the engine as a machine still offers some little chance of gaining upon the existing conditions of best work. The thermodynamic wastes are now by the best designers and constructors reduced to about ten per cent. in large engines, while the friction wastes of the machine are usually considerably more in that class of engines, though less in the simpler and lighter engines of the recent high speed type.

The plan adopted in the series of experiments to be described, in which Messrs. Carpenter and Preston proposed to endeavor to effect an analysis of the total internal friction of the steam engine, and to ascertain in what proportion it is distributed to piston and crosshead, crank pin and shaft, valve gear and guides, was to first determine the friction of the machine in the manner already practiced by them and by their predecessors in this work, then to dismantle the engine, part by part, driving the connected parts by a pulley and belt from the main line of shafting overhead, through a transmitting dynamometer carefully standardized, and thus to secure measurements of the resistance of part after part until all the rubbing parts having been thus examined, the sum of their resistances, at the normal speed of the engine, should give the total internal friction of the engine and the percentages of the whole due to the resistances of each point of connection or rubbing.

In each experiment the endeavor was made to secure precisely the conditions of operation, so far as was practicable, which were usual in its regular working. For instance: the engine was always heated up by its own steam when the resistances of the piston and the valves were to be measured; the speed of engine was kept the same when testing the friction of journals as when it was doing its full work; the valve, balanced and unbalanced, was tested under the usual boiler pressures, as well as unloaded, and exactly as possible, and thus every precaution that could be devised was adopted to secure precisely the results that should be observed, were such observation possible, when the machine was at work. The engine was first driven by the shafting, and through the dynamometer, with everything connected and the cylinder heated up to its usual temperature by a run, immediately preceding, under steam, the cylinder heads and steam chest cover only being removed to prevent any pump-like action of the engine while so driven. Next, the piston was disconnected, and the power demanded to give the engine its regular speed was observed with all other parts connected and moving; thus obtaining a measure of the friction of the piston alone, by differences. Then the next point of connection would be broken, and another observation would give the friction of the next successive piece, and so on until the whole engine had been gone over, when the machine was assembled again, part by part, and thus a check obtained on the previous determinations.

The first step of importance was to secure a good standardization of the transmitting dynamometer to be employed in the work. This method required the use of a transmitting dynamometer of great accuracy. Sibley College possesses a number of such dynamometers, the accuracy of each of which was tested by comparison with a Prony brake, and also by lifting a known weight through a given space. The best result was given in each case by a dynamometer of the Morin type, built in the Sibley College shops. The principle governing its action is very simple, and is shown clearly by Fig. 1. A pulley, of which the rim, B, is shown, is

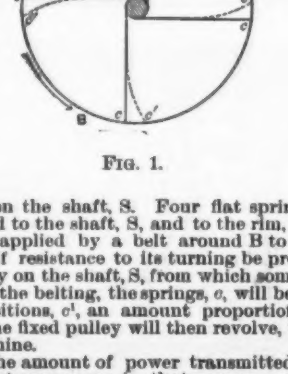


FIG. 1.

fitted loose on the shaft, S. Four flat springs are securely bolted to the shaft, S, and to the rim, B. Now, if force be applied by a belt around B to turn the pulley, and if resistance to its turning be produced by a fixed pulley on the shaft, S, from which some machine is driven by the belting, the springs, *c*, will be deflected into new positions, c^1, an amount proportional to the force, and the fixed pulley will then revolve, thus driving the machine.

To show the amount of power transmitted, and any variation that may occur in that power, a pencil is attached to the rim of the pulley, or to a post having an equivalent motion, and a recording apparatus, consisting of a series of gear wheels actuated by a spiral thread on a sleeve on the axis, causes a band of paper to move radially under the pencil. The recording apparatus can be stopped or started at will, without interfering with the motion of the machinery, by causing the loose sleeve to engage with a lug on the shaft. The results obtained with this dynamometer agreed closely with those results obtained by the Prony brake and by moving a known weight through a given space. The diagrams obtained from the dynamometer consisted of a series of waving lines of varying elevation and with different average ordinates. The undulations were produced by changes of speeds probably caused by the inequalities of belt lacings, etc.

The general appearance of these diagrams is shown in Fig. 2.

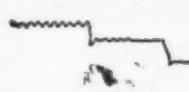


FIG. 2.

The dynamometer was calibrated three times: first, by attaching a brake to the same shaft, and comparing the diagrams with the brake readings; secondly, by direct pull with a spring balance against the springs of the dynamometer, and thus obtaining the ordinate for a given belt pull; thirdly, on the same principle as the first, but a spring balance was used, to measure the brake weights, instead of scales. The object of these calibrations was to obtain the ordinate corresponding to any given belt pull. The following results were obtained:

CALIBRATION OF DYNAMOMETER.

Comparison with Prony Brake.

1st Trial—Brake pulling against load of 52 pounds on Fairbanks scale.

Scale Load.	Brake Load, Pounds.	Pull on Dynam. Pulley.	Ordinate in Inches.
2	50	67·1	3·10
6	46	61·7	3·00
11	41	55·0	2·90
16	36	48·3	Lost
21	31	41·6	2·06
26	26	34·9	1·75
27	25	33·5	Lost
31	21	28·2	1·57
36	16	21·5	1.30
41	11	14·8	1·25
52	0	0·	0·4

2d Trial—Brake pull measured by a spring balance.

	5	6·7	0·54
	10	13·4	0·92
	15	20·1	1·23
	20	26·9	1·55
	25	33·6	1·80
	30	40·3	2·16

The diameter of the brake pulley, including belt, was 23½ inches; the dynamometer pulley, including belts, was 17½ inches.

CALIBRATION ON DYNAMOMETER.

Second method, by direct pull against springs of dynamometer.

This method was employed a number of times, and gave uniform results; the variations from the results of this trial and the first and third, as previously given, are believed to be errors incident to the use of the brake.

Pull on Dynam. Pulley, Pounds.	Ordinate, Inches.	Pull on Dynam. Pulley, Pounds.	Ordinate, Inches.
0	0·40	35	1·80
5	0·65	40	2·08
10	0·80	45	2·32
15	1·02	50	2·58
25	1·33	60	3·08
30	1·55	70	3·52

The mean of these three results corresponds very closely to this last, and, where plotted, gives a straight line, whose equation is

$$Y = 0{\cdot}046 + 0{\cdot}20,$$

Y being expressed in inches and X in pounds.

The diagram of the curves is shown, and in interpreting the results was used instead of the equation. (See Fig. 3.)

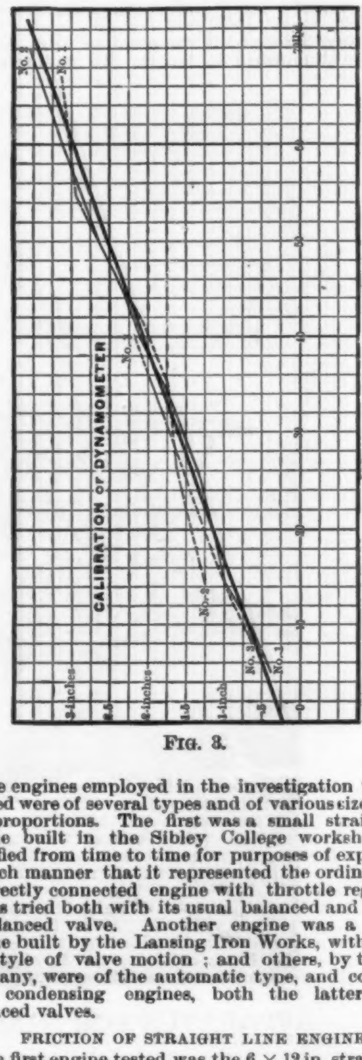


FIG. 3.

The engines employed in the investigation to be described were of several types and of various sizes, styles, and proportions. The first was a small straight line engine built in the Sibley College workshops, but modified from time to time for purposes of experiment, in such manner that it represented the ordinary type of directly connected engine with throttle regulation. It was tried both with its usual balanced and with an unbalanced valve. Another engine was a traction engine built by the Lansing Iron Works, with locomotive style of valve motion; and others, by the same company, were of the automatic type, and compound and condensing engines, both the latter having balanced valves.

FRICTION OF STRAIGHT LINE ENGINE.

The first engine tested was the 6 × 12 in. straight line engine, built by Prof. J. E. Sweet, while connected with Sibley College. This engine had been modified for experimental purposes in many ways, but still retained the principal characteristics of the straight line engine. The valve gear is arranged for a fixed cut-off, at any part of the stroke less than five-eighths, and the valve can be changed, by removing the pressure plate and fastening on a back, from a balanced valve to an ordinary slide valve.

For these tests, the power was obtained from the water wheel and main driving shaft, in the Sibley College shops, the speed of which was not always uniform, and was beyond the control of the investigators. The power was measured by passing it through the transmitting dynamometer. The speed was measured by a hand speed indicator, and also by an attached tachometer, which had been carefully calibrated. The tachometer results could only be used to correct errors, as readings to single revolutions could not be made.

In making this trial, and all others, the engine was first heated up by steam, the steam chest cover and cylinder heads were removed to prevent pump action, then as quickly as possible the dynamometer cards were taken. These diagrams were generally taken with the engine complete, and then successive cards with part after part removed. The engine was turned by power applied to its main driving wheel. The speed of the engine varied from 200 to 244 revolutions, and the results were corrected in accordance with the law, known to be true for that engine, that the friction varied directly as the speed. This correction, however, did not seriously change the results. Twenty-nine successful dynamometer cards were obtained, each of which may be considered as the average of several observations. The practical condition of working of a plain slide valve, with steam on, could not be obtained in these trials, because the cylinder was open to the air, and the friction obtained is no doubt too high for that particular case.

Table I. presents a record of the distribution of friction found in this engine and all essential data from later comparisons with other results from tests of the various engines afterward employed.

Table II. exhibits the method of variation of friction, and Tables III., IV., and V. its computed amounts.

TABLE I.

DISTRIBUTION OF FRICTION.

Straight Line Engine 6" × 12".

Log of trial with Morin Dynamometer.

Number.	Ordinate.	Pull in lb.	Revolutions per Minute.	H. P. Developed.	H. P. ÷ Revolutions.	H. P. Corrected for 230 Revolutions.	Steam Pressure in Engine.	Condition of Engine.
1	1·78	34·5	208	1·556	·007	1·710	0	Engine complete. Warmed up by steam. Cylinder head off. Steam chest cover and pressure plate off. All cocks open.
2	1·87	36·5	205	1·622	·008	1·822	0	
3	1·86	36·5	205	1·622	·008	1·822	0	
4	1·20	22·5	230	1·122	·005	1·122	0	Piston and piston rod dropped.
5	1·25	23·25	232	1·169	·005	1·159	0	
6	1·27	23·8	244	1·259	·005	1·189	0	Pressure plate and steam chest cover replaced.
7	1·28	24·0	245	1·275	·005	1·200	40	
23	2·04	39·0	186	1·573	·008	1·925	45	Balanced valve converted into slide valve. Steam pressure on back of valve.
24	1·90	37·0	186	1·492	·008	1·844	45	
25	1 82	35·0	201	1·525	·007	1·728	42	
26	1·81	35·0	214	1·624	·008	1·752	39	
27	1·92	37·5	201	1·634	·008	1·868	37	
28	1·67	34·0	217	1·599	·007	1·690	74	
30	1·19	22·5	229	1·117	005	1·112	0	Slide valve, piston and rod still off.
31	1·80	34·75	218	1·642	·0075	1·732	74	
32	1·07	19·5	205	0·867	·004	0·967	0	Main shaft and eccentric.
33	1·03	18·5	207	0·830	·004	0·922	0	
34	1·00	17·5	228	0·865	·004	0·873	0	Eccentric strap made as loose as possible.
35	0·95	16·5	225	0·805	·004	0·825	0	
36	1·10	19·5	227	0·960	·004	0·972	0	Connecting rod attached to crank pin.
39	1·26	23·0	215	1·072	·005	1·147	0	Engine complete except piston and rod. Slide valve attached. Cylinder hot.
40	1·84	35·0	198	1·502	·008	1·758	75	
41	1·29	24·0	222	1·155	·005	1·195	0	
42	1·92	37·5	211	1·715	·008	1·867	67	
45	1·24	23·0	223	1·112	·005	1·147	0	Slide valve dropped. Valve rod still attached.
47	1·39	26·0	222	1·251	·006	1·299	0	Balanced valve. Pressure plate and cover off.
48	1·28	23·5	220	1·121	·005	1·171	0	
43	1·29	24·0	224	1·165	·005	1·195	0	Pressure plate and cover added.
44	1·22	22·5	228	1·112	·005	1·222	58	

LANSING ENGINE TRIALS.

Distribution of Friction, 12"×18" *Automatic Engine.* —The remaining tests to be described were made at Lansing, Michigan, and on the engines built by the Lansing Iron and Engine Works of that place.

The first engine tested was a new 12"×18" automatic engine. A series of trials to determine change of friction with change of load was first made, which gave us the average friction, 8·91 H. P., whether loaded or light. Considerable difficulty was experienced in attaching the dynamometer, and it is found impossible to obtain the friction on each distinct part of the engine. For this trial the springs of the dynamometer were flexed in the opposite direction from that adopted when it was calibrated; the results were taken as proportional, and the total made to agree with the previous trial. The highest speed obtained was 68 to 70 revolutions; the normal engine speed was in the previous trial 190 revolutions. The friction horse power in the last column was obtained by multiplying by the proper ratio. In any event the percentage would not change.

Table V. exhibits the distribution of resistances obtained in this case.

The letters used under head of algebraic work stand for conditions shown in the other table.

Distribution of Friction, 7"×10" *Engine; Locomotive Valve Gear.*—The test was conducted in the same manner as the original Sibley College test, except that the power was supplied by a similar engine, and the dynamometer was located between the two. The engine was a traction engine used in thrashing grain; it had a common slide valve link and two eccentrics. It had been previously tested to find variation of friction with change of load. During the test the engine was taken to pieces in a thorough manner, as originally planned, and the results are in each case satisfactory. In the attempt to run with the connecting rod disconnected from the cross-head, a machinist held the free end of the rod. A speed of 206 revolutions, however, caused him to exert some force, so that this result is unreliable, as the test shows the same friction as with the main journals alone. The friction on the main journals was measured with the usual fly-wheel, which weighed 320, and with one that weighed 70 pounds to note variation in journal friction.

Table VI. shows the method of variation of friction resistances in this case, as the engine was gradually dismantled; and Table VII. exhibits its distribution among the several elements of the machine.

TABLE II.

SUMMARY OF THE LOG.

Distribution of Friction.

6"×12" Straight Line Engine.

Symbol.	Number.	Friction H. P.	Average F. H. P.	Parts of the engine producing friction.
A	34 35	0·873 0·825	0·849	Main journals.
B	32 33	0·922 0·966	0·944	Eccentric strap and main journals.
C	36	0·972	0·972	Crank pin and main journals.
D	30 41 43 45	1·122 1·195 1·195 1·149	1·165	Cross-head and pin, crank pin, eccentric and main journals.
E	40 42 23 24 25 26 27 28 31	1·758 1·867 1·925 1·844 1·728 1·752 1·868 1·690 1·732	1·796	Plain slide valve, cross-head and pin, crank pin, eccentric and main journals, with steam on.
F	43 6	1·195 1·189	1·192	Condition D, with balanced valve and pressure plate added
G	7 44	1·200 1·222	1·211	Condition F, with steam pressure.
H	1 2 3	1·710 1·822 1·822	1·785	Engine complete with balanced valve. No steam pressure, but engine hot.
I	4 5	1·122 1·159	1·140	Condition D, with balanced valve added, but pressure plate off.

TABLE III.*

COMPUTATION.

Distribution of Friction.

6"×12" Straight Line Engine.

Combination of Conditions.		Results H. P.	Individual part to which friction is due.
Algebraic work.	Arithmetical work.		
A	·849	0·849	Main journals.
B — A	·944 — ·849	0·095	Eccentric strap.
C — A	·972 — ·849	0·123	Crank pin.
D — C [B — A]	1·165 — ·972 — ·095	0·098	Cross-head and pin.
E — D	1·796 — 1·095	0·631	Slide valve, steam on.
G — D	1·211 — 1·165	0·046	Balanced valve, steam on.
H — F	1·785 — 1·192	0 593	Piston and rod.

* Symbol of condition in column of algebraic work explained in previous table. Diameter of main journals, three inches; weight in main journals, 1,500 pounds.

TABLE IV.

PERCENTAGE OF TOTAL FRICTION AND OF RATED POWER.

6"×12" Straight Line Engine, 20 H. P.

Parts of Engine.	Engine with Slide Valve.			Engine with Balanced Valve.		
	Friction H. P.	Per cent. of total friction.	Per cent. of Rated Power.	Friction H. P.	Per cent. of Total Friction.	Per cent. of Rated Power.
Main journals	0·849	35·4	4·2	849	47·1	4·2
Eccentric strap	0·095	4·0	0·5	·095	5·3	0·5
Crank pin	0·123	5·1	0 6	·123	6·8	0·6
Cross-head and wrist pin	0·098	4·1	0·5	·098	5·4	0·5
Valve (steam on)	0·631	26·4	3·2	·046	2·5	0·2
Piston and rod	0·593	25·0	3·0	·593	32.9	3·0
Total	2·389	100·0	12·0	1·804	100·0	9·0

TABLE V.

DISTRIBUTION OF FRICTION LOG OF DYNAMOMETER TRIAL. LANSING IRON WORKS, 12"×18" AUTOMATIC.

Rated 100 H. P.

Condition of Engine.	Symbol.	Mean Ordinate.	Reading from Calibration. Pounds.	Tension on Engine Belt. Pounds.	Speed of engine in Revs. per Min.	H. P.	H. P. for 190 Revs. per Min.
Engine in working condition and hot.	A	11·3	45·	76·5	68	2·96	8·88
Piston, cross-head, and connecting rod dropped	B	6·7	25·	42·5	68	1·51	4·53
Valve and eccentric also dropped	C	5·6	19·75	33·5	73	1·40	3·70

COMBINATION OF RESULTS.

Parts of Engine	Algebraic work.	Arithmetical work.	Frictional H. P.	Per cent. of total Friction.	Per cent. of power of Engine.
Main journals	C	3·70	3·70	41·6	3·7
Valve and valve gear, including eccentric	B–C	4·53—3·70	·83	9·3	0 83
Piston, cross-head, crank, and wrist pins.	A–B	8·88—4·53	4·35	49·1	4·35
Total			8·88	100·0	8·88

TABLE VI.

DISTRIBUTION OF FRICTION.

Traction Engine—Locomotive Type.

7×10. Lansing Iron Works.

Condition of Engine.	Symbol of Condition.	Revolutions of Engine.	Mean Ordinate.	Tension on Dynamometer Belt in Pounds.	Friction H. P. at Given Speed.	Friction H. P. 200 Revolutions.
Complete, hot, cocks open	A	196	5·35	19·50	1·47	1·50
" " back head off	B	202	5·68	20·25	1·58	1·56
Piston and rod out	C	202	4·36	14·75	1·14	1·13
Rod in, spider on, but piston rings out	D	200	5 14	18·00	1·40	1·40
Condition C with 40 pounds steam on valve	E	198	5·4	19·50	1·49	1·51
Valve and valve rod off	F	190	4·3	14·25	1·05	1·10
Remainder of valve gear off	G	203	3·6	12·00	0·94	0·93
Condition G with governor off	H	203	3·65	12·25	0 96	0·94
Cross-head and pin off (connecting rod held by attendant)	I	206	3·1	9·00	0·71	0·69
Main journals, standard fly-wheel, weight 320 pounds	J	200 190	3·0 3·1	8·75 9·00	0·67 0·66	0·67 0·69
Main journals, small fly-wheel, weight 70 pounds	K	262	2·3	5·75	0·57	0·44

TABLE VII.

DISTRIBUTION OF FRICTION.

7×10 *Engine.*

Combination of results. Rated 20 H. P.

Parts of Engine Causing Friction.	Combination.		Fractional Horse Power.	Per cent. of Total Friction.	Per cent. of Rated Power of Engine.
	Algebraic Work.	Arithmetical Result.			
Main journals	J	0·68	0·680	35·2	3·4
Crank pin, wrist pin, and cross-head	$\frac{H+G}{2} - J$	$\frac{·94 + ·93}{2} - ·68$	0·255	13·1	1·3
Eccentrics and links	$F - \frac{G+H}{2}$	0·165	0·165	8·2	0·82
Slide valve and rod, no lead	C — F	1·13 — 1·10	0·030	1·5	0·01
Effect of 40 pounds of steam	E — C	1·51 — 1·13	0·380	19·5	0 19
Piston and piston rod	D — C	1·40 — 1·13	0·270	16·0	0·135
Piston rings	$\frac{A+B}{2} - D$	0·130	0·130	6·5	0·065
Total			1·910	100·0	9·52

NOTE.—In the column headed algebraic work, the letters refer to conditions as denoted in preceding table.

(*To be continued.*)

MILL FOR CONCENTRATING SILVER ORES, AT LEADVILLE, COLORADO.

THE accompanying drawings illustrate a mill for concentrating silver ores, recently erected in Colorado. The plans were made and the mill completed in the summer of 1887, by Messrs. Taylor and Brunton, mining engineers, of Leadville, for the Dinero Milling and Mining Co. The mill is situated six miles west of Leadville and one mile from the mines of the company.

The ore-bearing lode lies in a granite formation and is of a peculiar structure, owing to the line of the formation or deposition of silver-bearing matrix having been determined by a pre-existing fissure in the granite. In past times the percolation of water, and other causes, decomposed the rock adjacent to the line of the fissure; this extended irregularly into the mass according to the greater or less resistance offered by the harder or softer portions, and in these cavities it is that the argentiferous blende and pyrites have been deposited.

The granite contained much feldspar, which, when decomposed, resulted in a substance causing considerable trouble from its stickiness and caking nature; this, together with any clay present, is called "schlickensides." The only difficulty presented in the treatment of the ore was this sticky material, present to the extent of 30 per cent. by weight, therefore it was considered inadvisable to crush and size by ordinary methods, because if the ore is damp, as is usually the case in coming direct from the mine, then rolls or other crushing machines form cakes, in which many rich particles of mineral are incased. These cakes not only very much interfere with subsequent separation in the screens, but would, during the process, break up into pellets and carry away ore particles in the overflow of the machines intended for the coarser kinds of ore. To get over the difficulty it was decided to use a strong current of water to follow the ore in its course through the mill, also to revolve the first, or return, trommel in water, so as to break up as much as possible all the schlickensides.

The general arrangement of machinery, shafting, and belting is shown by the engravings. The power is generated from a 50 ft. head of water, by a 15 in. double Leffel mining turbine on a horizontal shaft; the turbine is run at 650 revolutions to the minute, the shafting at 140 revolutions. The crushing power consists of an ordinary 7 in. by 10 in. Blake stone breaker, A; a pair of Cornish crushing rolls each 14 in. face and 36 in. in diameter, C; a trommel 8 ft. long and 3 ft. in diameter, D; from which the insufficiently crushed portions of the ore are carried back to the stonebreaker by a bucket elevator, O. In working the rolls each roller is independently driven by belting from the line shaft to each roll shaft receiving pulley; the main power for crushing is given to the fixed roll, that is, to the roll whose journal boxes are rigidly held in position on the bed plate; the journal boxes of the other roll may, on a heavy strain, slide along the bed plate, so as to give relief, should by any chance a large piece of steel or other incompressible material pass in with the ore. This fixed roller is driven by a 14 in. belt received on an 8 ft. bandwheel; it revolves slightly faster than the other roller, because, were they driven at the same speed, the same portions of the faces would be continually meeting, and wear into ruts would rapidly result. In order to thoroughly break up the cakes formed by the rolls, the return screen, D, revolves in an iron housing, E, kept full of water. The sizing apparatus consists of the return screen, D, determining the maximum size of ore particles, three ordinary trommels, each 6 ft. long by 30 in. in diameter, G, and one pyramidal hexagonal screen, G^3.

A further division of the through discharge from the hexagonal screen is accomplished by Brunton's hydraulic classifier cones, L, acting on the "Spitzkasten" principle, but in which slowly revolving mullers regulate the size of the openings through which the water current ascends, and by their motion prevent the bridging over of the openings by any portions of ore. The concentrating apparatus comprises four three-compartment through-discharge jigs, I, one of which, for the coarsest ore, is provided with "Herberle" gates; one Brunton hydraulic concentrator similar in construction to the classifiers, but giving a highly concentrated discharge, by reason of an up-water current acting on the ore particles coming direct from the dimension sizing—as distinguished from hydraulic sizing; and the final concentrating is done by three "Frue" vanning tables of the ordinary type, N. The mill is lit by thirty Swan incandescent lamps, and electricity is generated by a Brush dynamo fixed above the turbine on the cross beams at R; the dynamo is run by a direct belt from the turbine wheel shaft.

The course of the ore through the mill is automatic, after it has been shoveled by hand into breaker, A; from this it is carried by a current of water along the slightly inclined trough, B, through the rolls, C, into the return screen, D; from this the over-discharge, the coarser ore, feeds with the surplus water into the water-tight elevator, O, and is thereby returned to the stone-breaker and rolls for recrushing. From the return screen, D, the through discharge settles in water to the points of the hopper-shaped housing, E, in which the screen revolves; each point ends in a circular opening regulated as to size by a specially constructed gate valve, through which the ore particles are forced, by the head of water standing in the housing, into the trough, F; along this the ore is conveyed by the water to the series of sizing trommels, G. In these trommels the coarser portion of the ore passes over the wire screens and through the spouts, H, to the jigs, I, wherein it is finally concentrated; the finer portion passes through

Fig 2

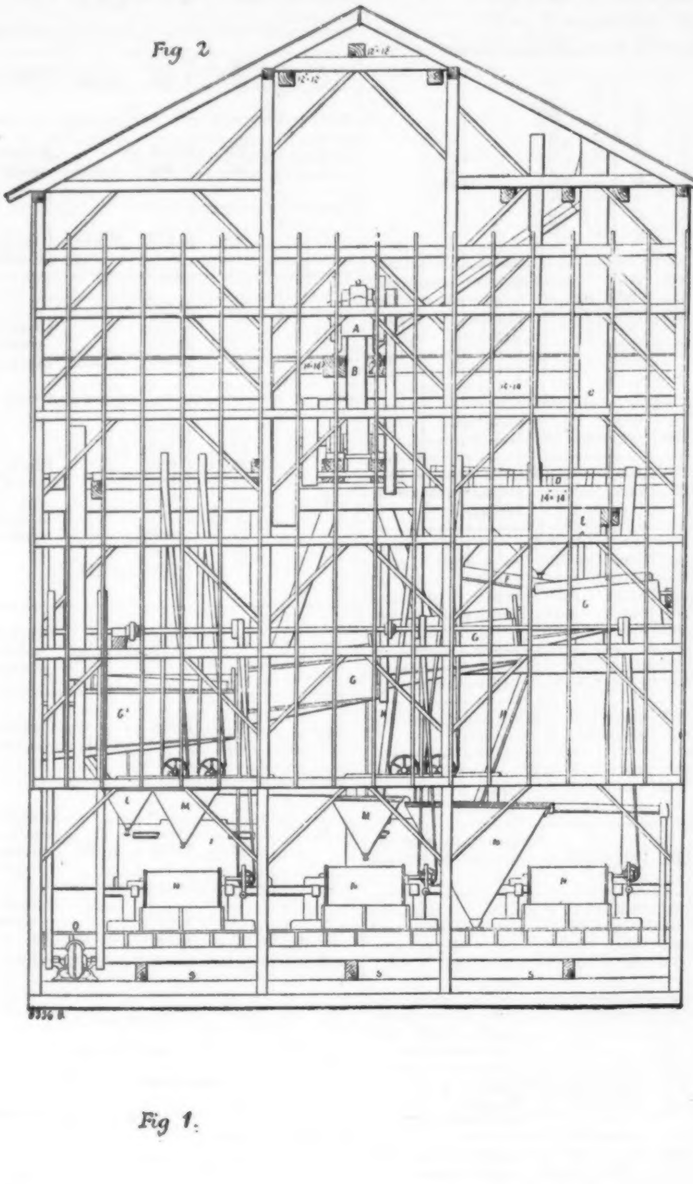
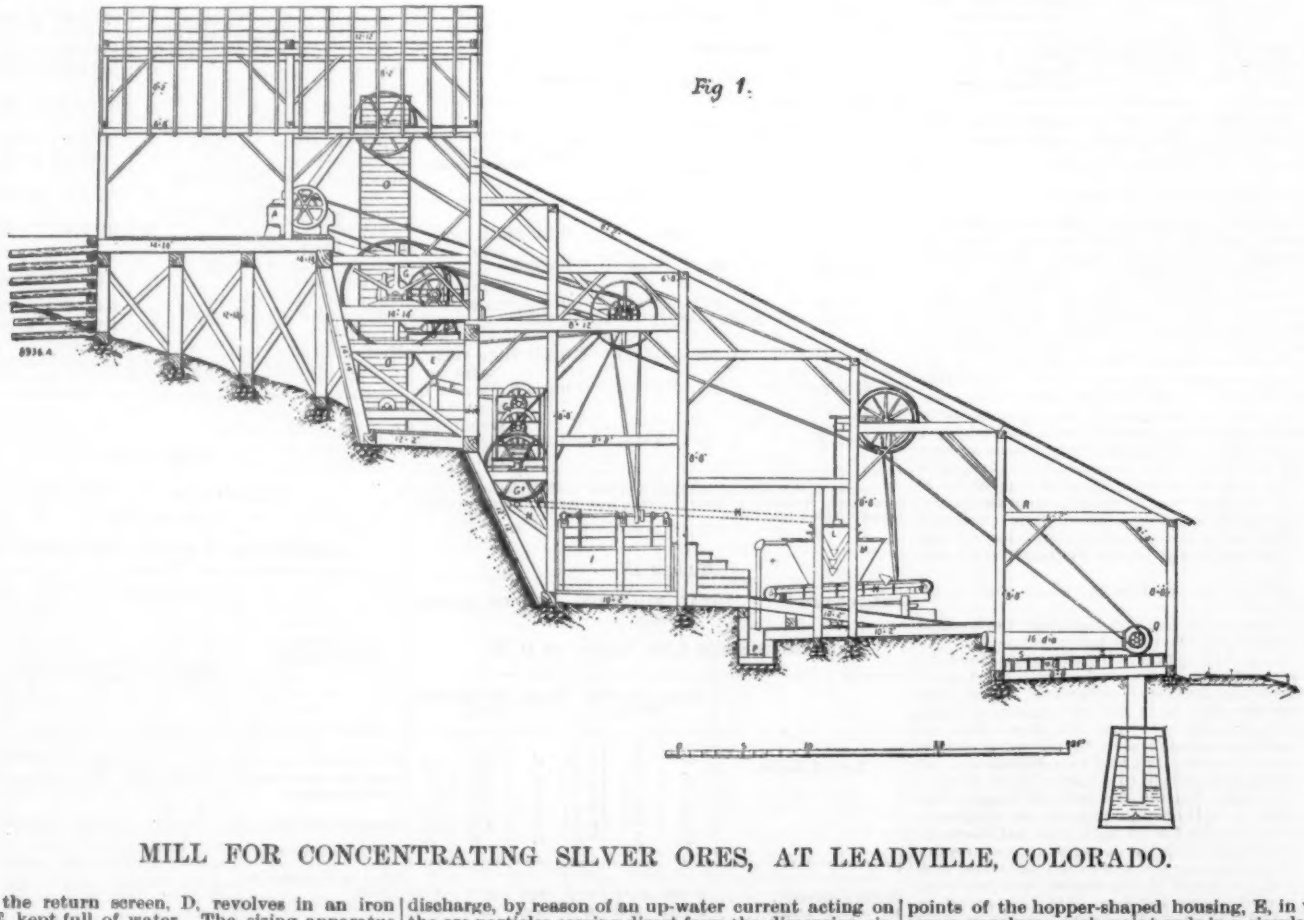


Fig 1.



MILL FOR CONCENTRATING SILVER ORES, AT LEADVILLE, COLORADO.

the screen, collects in the hopper underneath, and feeds into the next trommel, and so on from the upper to the lower; the smaller sized screen used has 3,600 holes to the square inch, and the ore that passes through it is conveyed by water into the pipe, K, shown in dotted line, to the hydraulic concentrator, L. The overflow from this concentrator passes to the classifiers, M, each of which furnishes a water-sized product to be treated on one of the vanning tables, N. From the jigs, I, the waste tailings discharge by short spouts—not shown, as they run under the floor—into the main tailings spout, P; into this spout the tailings from the vanning tables fall, also the overflow from the last series of classifiers. The ore concentrates fall into boxes under each jig, vanning table, and classifier, and from there are wheeled on to the draining floor, S, a continuation of the water wheel terrace; from this floor, when dried, they are loaded into railway wagons running alongside the mill on the road, T.

The outside dimensions of the mill are 84 ft. by 34 ft. The framing was cut from native pine and spruce growing in the district; the dimensions of the scantling are shown on the drawings. In the part of the mills above the landing floor, stonebreaker, and rolls, three 12 in. by 12 in. beams are fixed longitudinally in the roof; these fixtures are for the convenience of attaching tackle, to readily lift in and out any portions of the heavy machinery, should it be necessary for the purposes of repairs or replacement. The capacity of the mill is 50 tons of ore in twenty-four hours, and the total cost, ready to run, 4,500*l*.—*Engineering.*

IMPROVED FLAX SCUTCHING MACHINE.

OUR illustration shows a flax scutching machine, invented by Mr. J. O. Wallace, Belfast, which is now on view at the Irish Exhibition at Olympia.

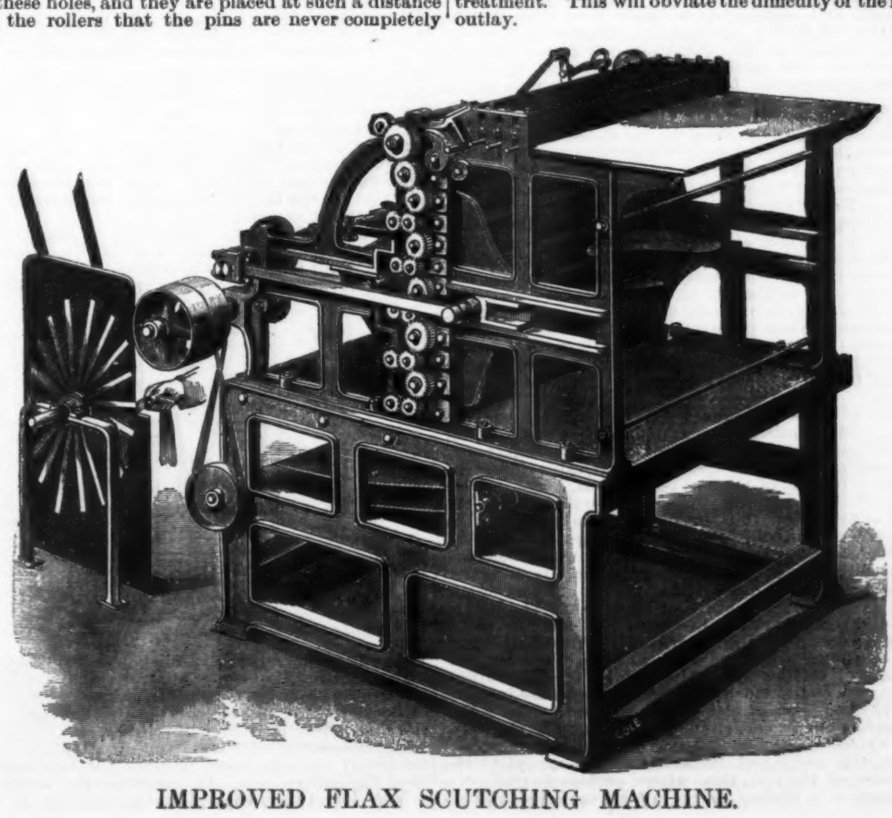
The flax is fed by hand between a series of horizontal fluted rollers at the top of the machine, as shown in the illustration below. These rollers are pressed against the stalks by means of steel springs, which allow the rollers sufficient play to admit of considerable variation in the size of the bundles which can be passed through the machine. After being crushed between these rollers, the stalks pass vertically downward between a series of smooth rollers arranged in pairs, with intervals between them, which are pressed together by steel springs, as in the case of the fluted rollers. The rollers receive an intermittent motion by means of the ratchet and pawl shown at the top of the machine, which is driven from a shaft immediately above and parallel to the driving shaft, with which it is connected by means of toothed gearing. The pawl receives its motion from an iron rod and a crank, which is driven by a spur wheel on the shaft. On opposite sides of the vertical series of the smooth rollers are arranged a pair of slides, which receive a horizontal reciprocating motion from two pairs of cranks on the same shaft. The slide next to the shaft is actuated by the two inner cranks, and the further one by the two outer cranks, one of which is visible in the illustration immediately above the driving pulley. The slides approach and recede from the vertical series of rollers simultaneously. Each slide is furnished with a series of horizontal rows of hard steel pins placed closely together, several rows being opposite to each of the intervals between the series of vertical rollers, and the motion of the slides and rollers is such that these pass through the stalks and separate the wood from the fiber, while the rollers are at rest. The rollers do not begin to move again until the pins have been completely withdrawn from the flax, and cease moving before the pins enter again. The smooth and fluted rollers are, moreover, connected by means of toothed gearing, so that they all move simultaneously. By this arrangement, any stress on the fiber, which was the principal cause of failure in the Cardon machine, is entirely obviated. To prevent the pins from becoming clogged by portions of the detached wood, or by extraneous matter entangled in the bundles, vertical brass plates or shields are fixed on each side of the intervals between the rollers. These plates contain rows of holes immediately opposite to the pins, which fit exactly into these holes, and they are placed at such a distance from the rollers that the pins are never completely withdrawn from the holes. These perforated plates are strengthened by the upper and perforated portions being bent into an L shape, so as to lie horizontally above each set of rows of pins, and also by means of an attached horizontal plate between each row.

The speed of the machine can be altered by changing the spur wheel which drives the rollers, and is in its turn driven by the ratchet wheel at the top of the machine. This spur wheel is shown at the top of the front side of the machine. In order to allow spur wheels of different diameters to be used, the distance between the centers of this spur wheel and that gearing with it can be altered by means of the cam-shaped bearing shown in the illustration. The fiber, after passing through the machine, is carried on by an endless web, which receives its motion from a shaft and pulley driven by a belt from a small pulley on the driving shaft. The fiber is then removed by one of the attendants, and "buffed" in a "buffer" of the ordinary revolving blade type, except that the blades are made lighter, as the straw is thoroughly broken up by the machine, and the buffing merely serves to remove any adhering portions of it. The buffer is shown on the left of the machine. The machine exhibited is capable of manipulating about 10 cwt. of retted flax in ten hours, and the yield of fiber is from 25 to 33 per cent. of the raw material, according to the character of the flax.

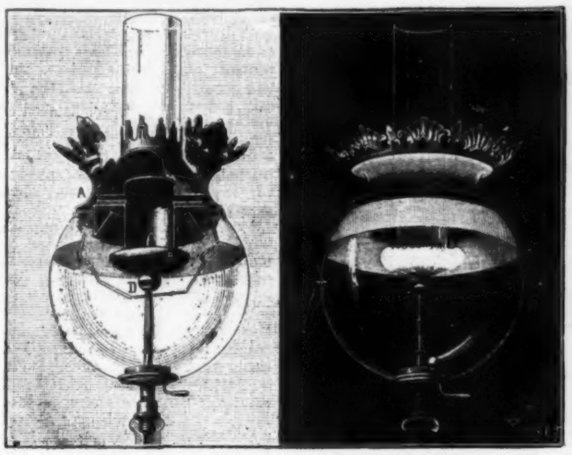
The machine requires three attendants—one to prepare the bundles of flax and hand them to the feeder, one to feed the flax between the rollers, and one to remove the fiber and pass it through the buffer; but the two attendants who prepare the straw in bundles and feed the machine can feed three or four more, and only one attendant for each extra machine, when placed alongside, is required to "buffer." Each machine absorbs about two horse power. In case an accident occurs to either of the rollers, or of the tools carrying the pins, the injured part can be removed, and duplicate parts supplied, so as to start work again in a few minutes. Other fibers can be treated as well as flax; but it is advisable to use larger and stronger pins for the coarser kinds. Rhea, hemp, New Zealand flax (Phormium tenax), aloe, and agave have been successfully treated in the machine. The loss in the manipulation of New Zealand flax is only about 7 per cent., instead of from 30 to 35 per cent., as in the ordinary process. The machine is being taken up by a Canadian syndicate and others, and they intend to establish depots in the neighborhood of the farms, to which the farmers may bring the raw material for treatment. This will obviate the difficulty of the initial outlay.

The government of India, as far back as 1869, showed the importance which they attached to the invention of a machine for decorticating the green ramie plant by the offer of a sum of £5,000 to the inventor of the best machine suitable for the purpose. The plant is easy of cultivation, and suitable for most tropical countries. In India, more particularly, it could be cultivated on an extensive scale. The subject, as has previously been mentioned in *Industries*, has also been taken up by the French Ministry of Agriculture, which has offered a premium of 6,000 francs for the best machine.

The fact that rhea or ramie fiber can be manipulated by Mr. Wallace's machine is, therefore, one of considerable importance. This fiber is of great strength, and silky in texture—so much so, indeed, that any one but an expert would probably mistake the prepared fiber for silk; but it has not hitherto been extensively used, owing to the difficulty of working it on the spot, and the cost of stripping the bark, which contains the fiber, by the slow and costly process of hand labor. These stalks are, on the average, about as thick as a man's finger, and of a very woody texture; but the machine treats them perfectly. The inventor informs us that for use with ramie fiber he would prefer to employ machines with working parts specially prepared and adapted, in order to break up the wood, and a second machine, with lighter rollers and finer pins, through which it would be taken after passing through the first, as the rollers of the machine constructed for scutching flax press the rhea fibers together more than is desirable.—*Industries.*



IMPROVED FLAX SCUTCHING MACHINE.



LEBRUN'S GAS BURNER.

LEBRUN'S GAS BURNER.

IT is especially since the electric light has begun to enter the domain of practice that important improvements have been made in gas burners. We have already given a description of different systems devised either for lighting streets or apartments and stores, and all of which mark a sensible progress in the utilization of the illuminating power of gas. The apparatus that we are now to describe, and which is the invention of Mr. Lebrun, is based upon the same principles as are the Siemens burner, the Wenham lamp, etc., but its mode of construction is different. Our engraving shows the external aspect of the lamp and the principal internal arrangements. It consists of a glass globe, into the bottom of which enters the copper tube or burner, D, through which the gas enters. Above this burner is placed a cylinder, C, closed on all sides, but the lower part, B, of which contains an infinite number of small apertures, and the upper part of which communicates, through the conduits, A, with the external air.

The upper part of the globe is closed by a metallic crown. A ring of asbestos interposed between the latter and the globe forms an airtight joint, so that there is no communication with the external air except through the glass chimney that traverses the crown.

The bottom of the globe is closed by a valve that is opened only at the moment of lighting.

The operation of the device is easily understood. When the gas has been lighted at D, and the valve has been closed, the air contained in the globe becomes heated and escapes through the chimney. A draught is then set up which forces the external air to pass through the conduits, A, into the cylinder, C, and to flow through the small apertures below. It consequently mixes intimately with the flames of the burner, D, and the combustion is as complete as possible.

The light is very white and steady, the gas is almost completely utilized, and there is a notable saving in the consumption.

The parts that compose the apparatus are so arranged that the light is diffused both above and below, thus permitting of lighting rooms throughout their whole extent, the most elevated portions as well as the others.

There are three different sizes made, corresponding to an illuminating power of 4, 9 and 16 carcels. According to Mr. Lebrun, the discharge per carcel is respectively for these three models 2,380, 2,015, and 1,950 cubic inches per hour.

The apparatus are provided with a screw thread that permits of substituting them for old burners on already existing chandeliers, candelabra, etc.

The use of apparatus of this kind will continue to increase further and further, not only in drawing rooms and in stores where a bright light is needed in the show windows to attract the attention of customers, but also in offices and studies, where the often defective lighting ruins the eyes of those who are obliged to work therein. From a hygienic point of view, too, it is necessary to seek gas burners in which the combustion proceeds as perfectly as possible. One of the reasons why the electric light is demanded is that the air is preserved in its utmost purity. Whatever be the undoubted advantages of that light, it must be recognized that in

certain cases, in the absence of central stations, the installation of it is practically impossible. In a provincial theater, for example, in which are given but a limited number of performances a year, and which remains closed during the summer, the expense of the first establishment and the keeping in repair would in nowise respond to the service rendered; but that is no reason for holding fast to the old, and this is one of the cases in which improved gas burners may find an application.—*La Nature.*

THE FRICTION OF METAL COILS.*

By Professor HELE SHAW and EDWARD SHAW.

COIL friction has long been used as a powerful means of communicating or retarding motion. Even where only a partial coil is employed, as in the case of leather

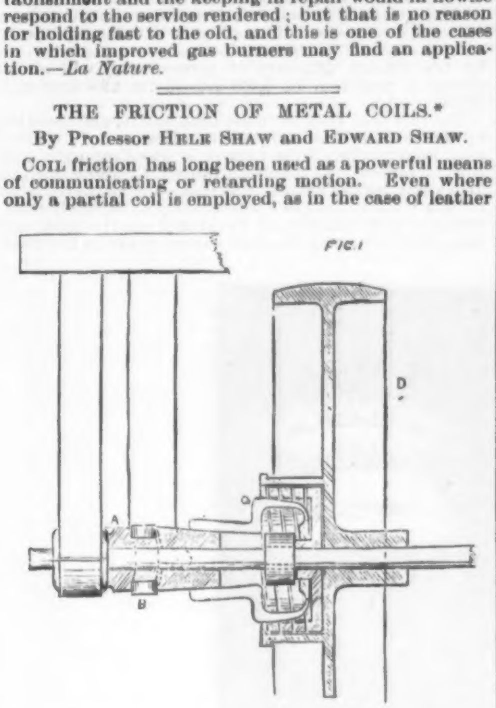


FIG. 1

or rope belting and flexible metal brake bands, the frictional resistance to be obtained by small pressures is very considerable; but where several complete convolutions are used, the effects to be produced are unlimited. Thus a rope, half a turn of which is taken round a post, will enable a man at one end to sustain a force three times as great at the other; but the resistance is multiplied three times for each half turn, so that in four or five turns a resistance of several hundred tons might be obtained, and the result only limited by the ultimate tenacity of the rope. On first thoughts, it would not be obvious that, with the exception of flexible metal bands and wire rope, metal could be employed in coil friction. In exactly similar circumstances this certainly could not be done; but suppose the conditions to be altered, and the metal coil to be only used under circumstances which do not require it to be unwound as is done with rope, then the properties of coil friction may also be taken advantage of, if the coil is sufficiently flexible for the purpose. It is true that metal is inferior in frictional resistance to rope, but this advantage may easily be obviated by using a greater number of coils, whereas the much higher tensional strength and durability of metal point to many valuable applications. The chief applications, which have been made with more or less success, have been in connection with clutches and brakes, and the principle of operation is very simple. The metal coil is either wound round a shaft or the sleeve of a pulley, or else it is contained within a cylinder attached to either. One end, which will always be referred to in the present paper as the "tail," is by some means or other brought into frictional contact with the shaft, sleeve, or cylinder, and is thus carried round if the surface be in motion, or retarded if the coil itself be in motion and the surface at rest. The attachment of the "head" of the coil prevents its following the tail until a considerable tension is put upon the whole coil. Thus, if the coil incloses the shaft or sleeve, it is made to wind up upon the shaft, becoming of less internal diameter and taking a frictional grip throughout its whole length; but if, on the contrary, it is inclosed in a cylinder, it is made to unwind, and so expand. In either case the result is the same, and a force of any required magnitude may be transmitted by this means. In order to illustrate this action, a piece of apparatus has been devised by the authors which may interest those who have never seen any example of the power of metal coil friction. A weight of 56 lb. is raised by a drum and handle. The shaft—1 in. in diameter—to which the drum is attached passes through its bearing in the

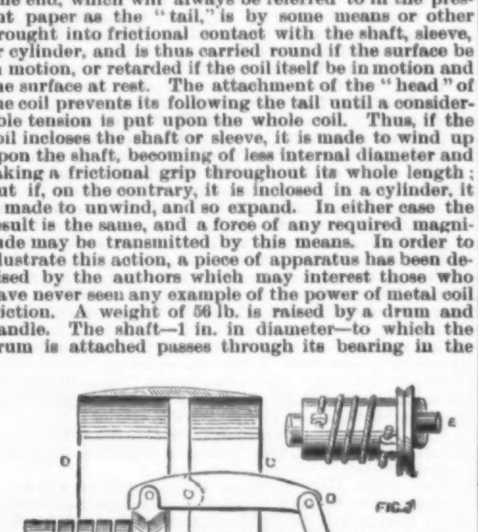


FIG. 2

frame, and is attached to the head of a metal coil of iron wire ⅛ in. in diameter. The coil incloses a sleeve carried by the frame, and the tail of the coil is free. As long as this is the case, the whole weight of the 56 lb. has to be sustained by means of the handle; but if a weight of 10 oz. is now suspended to the tail, a grip is obtained throughout the coil, by means of which the weight is sustained, which, from the difference of leverage, is equivalent to a force at the head of the coil of 200 lb. The load has in this way been increased at a previous trial until the head of the coil was torn off without adding to the weight at the tail. If the small weight is raised, the load falls; but its fall is instantly checked by releasing the small weight again. To show the effect of the number of convolutions various coils are substituted, and it is seen that when there are only four coils instead of eight, an increased weight, many times as great, is required to sustain the load. The effect of simply twisting the tail of the coil is very remarkable, as may be ascertained by means of the small wire coils now passed around the room. In this case it is not necessary to hang any weight at all upon the tail itself; and the self-sustaining action of the coil, which permits perfectly unconstrained motion in one direction, but instantly checks any motion in the other, is very striking. This effect is still more strikingly exhibited by means of the experimental apparatus. The tail of the small coil is twisted so as to just touch the shaft with a slight pressure. The load is then raised, and no resistance whatever is felt from the coil as long as the handle is being turned in the corresponding direction; but immediately the handle is released and the weight tends to fall, the coil comes into operation, and grips the shaft with a force which not only prevents the weight from falling, but also resists the further load now applied, the two being together equivalent to a total pull of nearly 1,000 lb. upon the coil. The important applications of this kind of action in self-sustaining hoists, silent feed motions, and for other purposes, are obvious.

Coming to the applications of metal coil friction which have been proposed, we find that, in 1877, Mr. Rider, an American, devised the friction clutch shown in Fig. 1. In this clutch a cone sleeve, A, is moved by means of a lever acting at B, and so throws open a split cone lever, C, and wedges out the tail of the coil against the cylinder in which it is inclosed. The coil, which is revolving, is thus unwound, and so presses upon the inner surface of the cylinder, which it carries round, and with it the pulley to which it is attached. Fig. 2 shows an application of the converse and most usual case, in which the coil winds up and closes upon a shaft or sleeve which it surrounds. This friction clutch was invented by Mr. Sterling in 1882, and its action is easily understood. A sleeve, A, carries along one end of a toggle joint, B, and so pushes out the end of the lever, C, and thus presses the tail end of the coil. The coil consequently tightens upon the boss of the pulley, D, and carries it round. There is also an example of wire rope coil friction shown at E, Fig. 2. Fig. 4 shows an

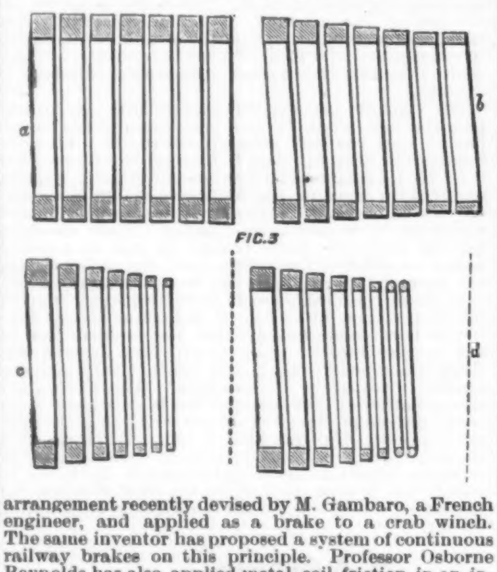


FIG. 3

arrangement recently devised by M. Gambaro, a French engineer, and applied as a brake to a crab winch. The same inventor has proposed a system of continuous railway brakes on this principle. Professor Osborne Reynolds has also applied metal coil friction in an ingenious arrangement for turning the valve rods of the experimental steam engine at Owens College, thus enabling the governor to be the means of almost instantly altering the position of the slides, thus regulating the admission of steam. Those who have seen this arrangement at work must have been struck by the suddenness and force with which the coil comes into action. Notwithstanding these and other applications of coil friction, the actual amount of knowledge on the subject, at any rate in a published form, is very small, and the accepted theory of ordinary coil friction takes no account of the comparative rigidity of the coil, and is not directly applicable in the case under discussion. Mr. Edward Shaw, in attempting to make use of metal coils, found various practical difficulties and apparently anomalous results, which led the authors to think it worth while to make some experiments bearing upon certain features in the application of this form of coil friction.

Form of Coil.—The first points to be considered are those of the requisite form and dimensions of coil, for it is obvious that while sufficient strength is required at the head of the coil to resist a considerable force, the tail need not be of similar section. It is not merely waste of metal to have the section uniform, but the want of flexibility thus entailed seriously impairs the efficiency of the coil. Fig. 3 will illustrate this point, in which *a* shows the section of a coil which has been adopted by one or two inventors, while *b* is a section of the coil reduced in thickness, but of uniform width. This has the disadvantage of being too broad at the tail, and the quantity of lubricant getting under such a surface prevents the initial grip taking place so readily. Fig. 3*c* shows a very efficient form in which the advantage of smaller space (the number of convolutions being as in *b*) and more sudden initial grip are insured. A very good form of coil is that shown in *d*, in which the last coil or two are circular in section. M. Gambaro and Professor Reynolds have both employed coils of decreasing width and thickness. With regard to the diameter of the coil, this, where perfect flexibility is assumed, is a matter of no importance, except as regards the obvious effect upon the leverage at which the resistance acts. With metal coils the case is different, as the larger the diameter the more readily the surface comes to its bearing for a given cross section; and with a given initial clearance the comparative distortion is less, the greater the radius of curvature. In order to have the internal surfaces of true cylindrical form, several coils were rigidly held and bored out, some even being afterward scraped to a bearing. It was, however, found that there was no necessity for such refinement, as after a very brief period coils simply made by twisting a taper rod round a turned cylinder found their own bearing, and were quite as effective as those which had been bored out.

Relation between Force and Resistance.—Of the coils exhibited, those lettered *a*, *b*, *c*, and *d* had sections corresponding to those similarly lettered in Fig. 3. These

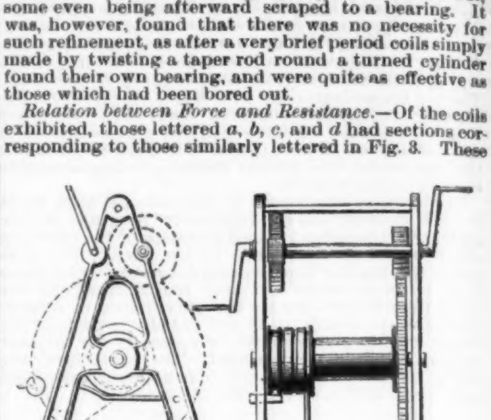


FIG. 4

four coils have been experimented upon by means of the apparatus shown in Fig. 5. On the face plate of a lathe were fixed cylinders upon which the coils fitting loosely were successively placed. The head, *h*, of the coil, C, was prevented from revolving by means of a lever, L, having a fulcrum at F, attached to the lathe bed, B. The lever, L, is counterweighted by means of a scale pan, W, hanging over a pulley, M, and the loads which are placed in the larger scale pan, W, thus have an effect just twenty times as great upon the head of the coil. The tail of the coil, *t*, was attached to a delicate spring balance, S, which in turn was suspended by a cord passing over pulleys, N N. By exerting a greater or less force in this cord any required tangential pressure could be brought to bear upon the tail. (*a*) Coil *a* consists of seven convolutions of ½ in. square cast steel, and, therefore, not being very flexible, was made a good fit upon the cylinder; but notwithstanding this a pull of no less than 25 lb. was required to raise the weight of the lever, which was equivalent to a force of 140 lb. at the head of the coil. The result of increasing the pull on the tail is shown below:

F...	25	37	41	43	47	51	55	59	63	67	70
R...	140	240	260	300	310	350	410	480	520	660	700

F = force on tail in lb. R = resistance on head in lb.

These results, which are not very uniform, and point to the evil of using rigid coils, were obtained with dry surfaces. The effect of lubricating the surfaces always appeared to be the reverse of what might be expected; thus in the present case, a pull of only 32 lb., instead of 37 lb., was sufficient when lubricant was freely applied to overcome a load of 240 lb., 37 lb. replacing 55 lb. and balancing 410 lb., 49 lb. replacing 70 lb. and balancing 700 lb. (*b*) Coil *b*, of wrought iron, consisting of eight convolutions of ½ in. × ⅜ in. tapering to ¼ in. × ⅛ in., required only a force of 3 lb. to make it lift the lever; but having once done this, the grip upon the surface was absolute, and apparently sufficient to raise the maximum pull that could safely be applied, which was 4,000 lb. The only effect of lubrication was to make the gripping action more sudden and violent. (*c*) Coil *c*, of steel, consisting of eight convolutions tapering from ¾ in. square to ⅜ in. square section, gave the following uniform series of results:

F	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
R	140	220	300	380	460	540	620	700	780	860	940	1020

F and R having the same values as before.

When the lubricant was used, the results, though not quite so uniform, did not differ greatly from the above, but were again slightly less, showing that lubrication makes the action more effective. (*d*) Coil *d*, consisting of ten convolutions of ⅜ in. square wrought iron, tapering to $\frac{3}{16}$ in. round steel, behaved exactly in the same way as coil *b*, but the effect was more marked, and 1 lb. on the tail resulted in an absolute and complete grip of the whole coil.

Influence of Velocity.—The effect of change of velocity of the moving surfaces was very surprising, the general result of decrease of velocity being to enable a small force on the tail to put the coil into operation.

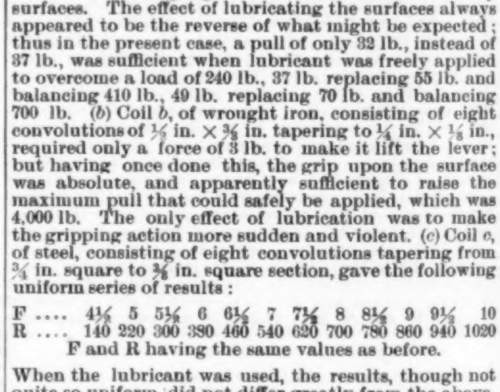


FIG. 5

This was not merely the case when the coil was revolving and the result of centrifugal force acting to keep the coil from contact, but was just as marked when the shaft or sleeve rotated and the coil remained at rest. Again, the chief effect of change of velocity seemed to be felt with coils similar to *a* and *b*, on the diagram, in which the broad surfaces seem to hold the lubricant more than the narrow ones. In experimenting upon coil *c*, it was found that with a surface velocity of 15 ft. a

* Paper read before Section G of the British Association, at Bath, September 11, 1888.—*The Engineer.*

minute 3½ lb. at the tail produced a force of 140 lb. at the head, whereas at 180 ft. per minute 5½ lb. was required to obtain the same result. With a very short coil of section c, having only five convolutions, the sleeve inside the coil could be rapidly revolved, with no apparent resistance; but directly the speed was reduced below a certain limit, the coil gripped with its full force. It may be that further experiments in this direction will throw some light on frictional resistance at high velocities. The foregoing results, which are a brief *resume* of the experiments upon the four typical coils, at first appear to be contradictory. Two of the coils behave in a very different manner to the other two. Thus, with a and c, after allowing for the stiffness of the spring, the experiments agree with the usual theory, which assumes that the forces at the two ends of the coil are directly proportional to each other when the arc of contact and coefficient of friction are constant, as was the case in the experiment. This is not so evident with the former of the two, in which the stiffness of the coil and the manner in which it acted prevented very accurate results being obtained. With the latter it is easy to see that an equation of the form

$$F = k R + m$$

represents the results, F being the force on the tail, R being the resistance on the head, while k and m are constants. The exact value of m is 3·625, this being a measure of the stiffness of the spring, since when the resistance is zero, m is equal to the force on the tail in lb., and it will be seen that for each increase of ½ lb. on the tail there must be an increased resistance of 80 lb. on the head. With the coils b and d, there is no such proportion between the two effects, but when once the coil comes into operation, the grip is sudden and absolute. The explanation is found by reference to the dimensions of the coils themselves, when it will be seen that the section toward the tail in the case of b and d is much less than that in the case of d and c; thus when the initial resistance in the latter case to closing the coil, due to its stiffness, is overcome, the bearing is continuous, and the force then on the tail is probably far in excess of that which would be required to even tear off the head of the coil. It will thus be evident that on attempting to make use of metal coils for practical purposes two distinct modes of operation are available, which, although so very different, can be obtained by merely varying the relation between the number of convolutions and cross section of the coil. Where a definite ratio is required between force and resistance, then the number of coils must be reduced or the cross section toward the tail increased; but if small constant force only is available to put into operation, whatever be the resistance at the head, then the convolutions must be sufficiently numerous and the tail end of the coil sufficiently flexible. The objection to the former is that any variation in the coefficient of friction makes a considerable difference in the result; but in the latter case, where the force required to start the coil is so extremely small, some effective means of releasing the grip when it reaches a certain definite amount would enable such coils to be effectively applied for purposes such as clutches and brakes.

THE PETITE ANSE SALT MINE.*

THIS mine, known also as the Avery mine, is situated on Petite Anse Island, New Iberia Parish, Louisiana. The island is about four miles from Vermilion Bay, an arm of the Gulf of Mexico, and is one of four islands or hills surrounded by the sea marsh, as shown in the accompanying map (Fig. 1). A fifth, Joe Jefferson's Island, or hill, is some distance from the sea marsh. These five islands—Belle Isle, Cote Blanche, Grand Cote, Petite Anse, and Jefferson—appear to be the tops of submerged hills, and occupy a line having nearly a northwest trend. To the north are a series of hillocks that extend at intervals to the hills of Northern Louisiana, which in turn appear to run into the Ozarks of Arkansas. Near the mine there is sandstone, also a thick vein of lignite. Bones of the mastodon have been found in considerable quantity in this neighborhood, and some specimens have been sent to the Smithsonian Institution.

I will not give here a geological description of the country, since this has been abundantly done already by Hilgard, Goessmann, Thomassy, and other able writers. It will, doubtless, be sufficient to call the reader's attention to the accompanying geological section of Petite Anse Island (Fig. 2), copied from Prof. E. W. Hilgard's map.

The salt mine and Petite Anse Island are owned by the Avery family, an old and honored family in Louisiana. The New Iberia Salt Company is the lessee, J. C. Haskell being general superintendent, S. L. McCalla mining engineer, and John Hamilton mill superintendent. As far back as the beginning of the present century salt springs were known to exist on the island, wells had been dug, and salt made for local consumption. During the war much of the Southern country was cut off from its supply of salt, and the island became a busy place for its manufacture. The supply of brine proving insufficient, an old well was cleaned out under the direction of Mr. John M. Avery. In digging this well still deeper the negro at work told his master that he had struck a log and could go no further, whereupon Mr. Avery descended and discovered a hard rocky substance, which, upon examination, proved to be pure rock salt. This, the first discovery of the salt, was made at a depth of only 16 feet. It put an end to the manufacture by evaporation. Pits of rectangular form were sunk and earth was stripped from the salt, which was blasted out by underhand stoping. Wagons by the thousand were used to transport the rock salt. Upon the occupation of the country by the Federal forces the work of mining was suspended.

The depth of the salt has never been determined, but the surface area underlaid by the depost is estimated to be about 150 acres. The salt is very pure and compares favorably with various rock salts and with products of evaporation pans, springs, wells, and lakes. The following table of analyses of salt speaks for itself. In the analysis of the Avery salt, many eminent chemists agree.

galleries cross each other at right angles and the ground plan strongly resembles a chessboard.

Galleries aggregating nearly one mile in length have been run on the upper level and some 700 feet on the lower.

The stratification plans are clearly denoted, and at first sight appear to have been thrown into a vertical

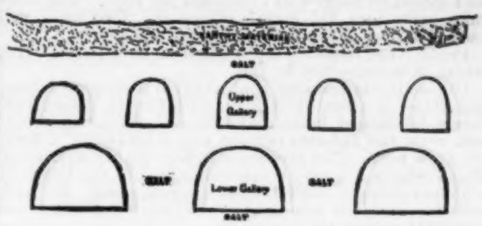


FIG. 3.

position throughout; but a close examination reveals the fact that the structure is folded, and shows three anticlinal axes in the first level, with the corresponding synclinals in the lower level. In *Harper's Monthly Magazine* for May, 1888, will be seen (p. 909) a cut of a salt quarry at Iletsk, in which the structure is folded.

ANALYSES OF SALT.

Varieties of—	Chloride of sodium.	Chloride of potassium.	Chloride of calcium.	Chloride of magnesium.	Sulphate of lime.	Sulphate of magnesia and soda.	Alumina and iron.	Residue.	Water.	Authorities.
Rock salt—										
Avery salt mine	98·88	....	trace.	trace.	0·79	....	....	....	0·33	Goessmann
Wieliczka, Austria	100·00	....	....	trace.	....	....	....	....	....	Bischof.
Berchtesgaden	99·93	....	....	0·07	....	....	....	....	....	"
Hall, Tyrol	99·43	....	0·25	0·12	0·20	....	....	....	....	"
Hallstadt, Austria	98·14	trace.	....	....	1·86	....	....	....	....	"
Stassfurt, Prussia	94·57	....	....	0·97	0·89	....	1·12	2·23	0·22	Heine.
Vic, Ger. Lorraine	99·30	....	....	....	0·50	....	0·20	....	....	Berthier.
Jebel-Melah, Algeria	97·00	....	....	....	3·00	....	....	....	....	Fournet.
Ouled-Kebbah, Algeria	98·53	....	0·93	0·54	....	....	....	....	....	"
Carrickfergus, Ireland	96·28	....	....	....	3·50	0·08	....	....	0·14	G. H. Cook.
Santo Domingo	98·83	....	....	0·04	1·48	....	....	0·01	0·07	Goessmann
Salt from wells and lakes—										
Onondaga, N. Y.	97·41	....	0·15	0·18	1·26	....	....	....	1·00	G. H. Cook.
Pittsburg, Pa.	96·70	....	0·53	0·07	....	....	....	....	2·70	"
Kanawha, W. Va.	91·31	....	1·26	0·43	....	....	....	....	7·00	"
Hocking Valley, O.	95·07	....	0·61	0·04	0·10	....	....	....	3·40	Goessmann
Pomeroy, O.	96·42	....	0·53	0·18	....	....	0·05	0·16	2·66	E. S. Wayne
Cheshire, England	96·36	....	0·01	0·02	1·17	....	....	....	2·44	G. H. Cook.
Dieuze, Ger. Lorraine	97·59	....	....	....	1·02	0·89	....	....	0·50	"
Droitwich, Eng	96·93	....	....	0·02	3·05	....	....	....	....	"
Goderich, Ont.	97·03	....	0·01	0·03	1·43	....	....	....	1·50	Goessmann
Saginaw, Mich.	92·97	....	1·09	0·50	0·33	....	....	0·01	5·10	G. H. Cook.

The galleries of the second level are run 80 feet in width and 45 feet in height, leaving supporting pillars 60 feet in diameter. The lower pillars are so left that the weight of the upper ones rests upon them in part, if not wholly, with a thickness of at least 25 feet of salt rock between.

There are 16 to 25 feet of earth above the salt deposit. The contour of the latter conforms nearly with that of the surface. The working shaft is 168 feet deep. The depth to the first level or floor is 90 feet; to the second, 70 feet further. The remaining 8 feet are used for a sump. The galleries of the first level were run, on an average, 40 feet in width and 25 feet and upward in height, leaving supporting pillars 40 feet in diameter.

Fig. 3 is a rough draft of a vertical section. The

The method of working shown is similar to that formerly employed at the Avery salt mine.

In running a gallery the first work is the "undercutting" on the level of the floor, of sufficient height to enable the miners to work with ease. The salt is then blasted down from the overhanging body. The yearly output is about 50,000 tons.

I am indebted to Major McCalla, the mining engineer of the company, for important data, and also for the following statement, which I give on his authority:

"The salt as it comes from the mine is dumped into corrugated cast iron rolls, which crush it. Next it goes into revolving screens, which take out the coarser lumps for 'crushed salt,' and let the fine stuff pass to the buhr stones. These grind the salt, and from them

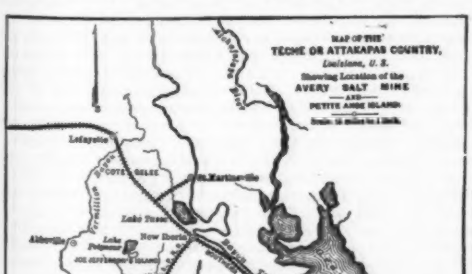


Fig. 1.

Fig. 2.

* A paper by Richard A. Pomeroy, New Iberia, La., in the *Transactions of the American Institute of Mining Engineers*.—*Engineering and Mining Journal*.

it goes to the pneumatic separators, which take out the dust, and separate the market salt into various grades. Taking the dust out is essential to the production of a salt that will not harden, since the fine particles of dust deliquesce readily, and on drying cement the coarse particles together. The drill used in the mine is what is known as the 'Russian auger.' It is turned by hand, and forced by a screw of 12 threads per inch. The holes take cartridges 1½ inches diameter. Two men will bore 75 feet of hole per working day of 8 hours."

Petite Anse Island is ten miles from New Iberia, with which it is connected by rail.

Unlike the barrenness that so often surrounds mines, the island is a beautiful park, with forests, grassy parterres, miniature lakes, and streams. Sugar cane, cotton, corn, the Tabasco pepper, and a profusion of flowers grow here. The scenery is indescribably charming. The Teche is a lovely meandering bayou, the banks of which are fringed with live oak, cypress, pecan, ash, and willow. It is the scene of busy industry. Along it are saw mills, shingle mills brick kilns, ice factories, machine shops, cottonseed oil mills, sugar factories, and cotton gins. Cotton and other factories would certainly thrive here. Steamboats are constantly plying upon the bayou, some to New Orleans, some to Morgan City, and some between minor local points. The Teche is not a sluggish stream, its banks are high, and the country is never overflowed. The soil is excellent and the climate healthy and delightful. The farmer accustomed in the North to interruptions from snow and ice can here work out of doors every week in the year. Invalids and others worn out by the rigors of winter can recuperate their wasted strength in this balmy atmosphere. The sea breezes roll over the country and give health and long life to its inhabitants. The climate is, in short, a medium between a tropical and north temperate, combining most of the advantages of both and the evils of neither.

To the geologist this is a country of constant surprises in the form of materials brought from distant sources, and traces of ancient channels now abandoned. He finds clay from the Red River, alluvium from the Mississippi, and sand and gravel that remind him of the Bijou Basin in Colorado. Red River has been a fickle stream in its journeyings to the sea, changing its course from time to time, until finally it has been mostly lost in the waters of the Mississippi. But it has left its marks from the Sabine to the Atchafalaya.

ROLLING SEAMLESS TUBES.

*On Rolling Seamless Tubes from Solid Bars or Ingots by the Mannesmann Process.**

By FREDERIC SIEMENS, C.E.

STEEL possesses high qualities and great strength, which make it peculiarly fitted for many purposes both in industry and the arts. The same observations apply in a lesser degree to toughened or hard glass, and yet these materials have been comparatively neglected. This neglect is owing in a great measure to the fact that steel in its present cheapest form and toughened glass are somewhat new articles, and that until recent discoveries were made, difficulties were encountered in working and transforming them that induced the general public to use, by preference, wrought iron and soft glass, which could be welded and cut respectively, as steel and hard glass could not be, by the means generally known.

The use of steel in replacing wrought iron has been very slow. In recent times only has a general advance in this respect been made. This advance is partly owing to the new methods of producing steel, the Bessemer, the Siemens, the basic process of Gilchrist and Thomas, and partly, also, by newly discovered means of manipulating the products of these inventions.

The subject of this paper will be a new and important invention recently made in the manipulation of steel. The process consists generally in a method of rolling metal into seamless tubes, and it will contribute greatly to increase the use of steel, and principally of those kinds of cheap steel produced by the methods mentioned above. The open hearth or Siemens steel, above all, possesses the advantage of cheapness, of having the right amount of toughness and homogeneousness and other qualities which fit it for the special purpose of rolling solid ingots direct into tubes.

Most engineers will have heard of the tube-rolling process of Messrs. Mannesmann. The modest title barely indicates its great importance. I myself took an interest in this new invention, because I was desirous of increasing the use of open hearth steel, which, as well as copper, I was informed, was specially adapted to the process, for which wrought iron was comparatively unsuitable.

Tubes occupy an important place in the wants of mankind. Besides their use as tubes properly so called, they possess, also, the most advantageous form for columns, rods, axles, bearers, struts, etc. A given quantity of material can be formed into no shape so strong as the tubular.

Hitherto steel tubes could only be made with difficulty and at high cost by a complicated process with imperfectly welded seams and a longitudinal fiber. Now from a rough ingot of cheap steel with one or at most two operations a perfect tube without seam and with a circular fiber is produced. It may be seen from this bare statement how great is the importance of this invention. If it is considered that by the process in question tubes of great length and diameter and of almost any desired thickness of metal can be produced at a comparatively low cost, airtight and possessing treble or quadruple the resisting power of the best welded tubes of wrought iron, it can hardly be doubted that a great future is opened out for their use in technical arts, industries, architecture, and also in war materials. New branches of industry may also be expected to arise, as we now have the means of bringing into use the best of material in the lightest and at the same time strongest form.

At the present time to roll a bar of iron, two horizontal rolls, as shown in Figs. 1 and 2, revolving in opposite directions, are used. If the section of the finished bar is required to be of any given form, grooves are cut around the rolls of the sectional form which the bar is required to assume. Passed longitudinally between the revolving rolls, the bar is forced into the grooves and reappears moulded to the desired form. The rolls do not make the bar revolve, they act simply on its surface, drawing the material forward, and forcing it into the prepared grooves, at the same time elongate it and reduce its sectional area. The fiber produced in the finished product is of course longitudinal. Tubes are also made in this way. The prepared sheet of wrought iron is bent till the sides overlap, and the longitudinal seam thus made is welded while passing through the rolls on a mandrel placed inside. The ordinary patent welded wrought iron tubes made in this way have also a longitudinal fiber.

Another way (Figs. 3 and 4) of rolling is known, and is used for straightening and polishing bars, to which a rotating motion is imparted by two or three rolls revolving in the same direction. These rolls are for the most part placed parallel to one another, and the bar to be operated on is introduced in the direction of their longitudinal axis, that is, at the ends instead of at a right angle to the rolls. In such rolls the bar is not drawn forward, but simply rotates, and if sufficient pressure is given, the bar is elongated, but no decided fiber is produced.

Between the two kinds of rolling described above, which may for convenience be called longitudinal and circular respectively, another system of polishing and straightening bars and tubes occupies a kind of middle position.

So also does the Mannesmann tube-rolling process. The systems differ, however; the first acts on the surface only of the bar or finished tube, whereas the latter actually makes the tube and, in making it, displaces the material of the bar or ingot acted on, and imparts to it a fiber running in a spiral around it. In both systems two or three rolls may be used together, turning in the same direction and, consequently, imparting a rotating movement in the opposite direction to a bar laid between them. The two or more rolls (Figs. 5 and 6), however, do not lie normally, nor even parallel, but at angles to the axis of each other, and the axes of these rolls cross one another and that of the bar, forming somewhere in space acute angles in opposite directions with each other and with the bar lying between them. When thus set, the rolls act on the bar to draw it forward, as well as to make it revolve, or, in other words, they impart to it a spiral movement. Though constructively both systems of mills may appear much the same, they differ widely in their mode of working and in their results. This arises from the position which the article acted upon, and which we will continue to call a bar, is made to take up and the very different action and form of the rolls. In the Mannesmann machine a certain relation is maintained between the forward movement of the bar and its rotating movement, and if the proportion between longitudinal rotary motion is properly adjusted to the special material acted on, the displacement in the substance of the bar is regulated so that a systematic twist is given to the fiber, by which not only irregular breakage of the material is avoided, but an energetic working action is secured, causing the great strength and toughness the tubes produced by this process are proved to possess.

The old straightening and polishing machine, although outwardly similar to the Mannesmann tube-rolling machine, owing to the form and position of the rolls and bar, admits of no twisting and displacement of material, and, consequently, this machine confines itself to surface action, as, indeed, it professes to do by its title.

The following remarks may assist in clearing up this singular difference, and explain the peculiar action of the Mannesmann rolls, which, while acting on the outer surface of a solid bar, produce a regular hollow space inside the same, in short, a tube. To obtain a simple forward spiral action of the bar, the length of the rolls is immaterial; it will take place when the rolls are reduced to the form of thin disks. Supposing the disks to be infinitely thin, or, what is the same thing, that their outer edges are reduced to a mathematical line, and no sliding motion takes place, the bar must still move forward spirally, its spiral velocity being equal to the velocity of the outer circumference of the disks. If, instead of one pair of such thin disks, several pairs of disks of regularly increasing diameters are made to revolve on the same axis, the outer circumference of each disk will revolve with greater velocity than that of the preceding one. The same bar is, however, drawn forward through the several pairs of disks, and thus, as each part of the bar enters successively a more advanced pair of disks, the velocity with which that portion of the bar rotates increases, and it is drawn forward by each succeeding pair of disks, as they catch hold of it, with ever increasing speed.

It will be understood that a bar passing through such a series of disks, no slipping being possible, the material of which it is composed cannot retain its original area or volume. The diameter of the bar being regulated by the disks, while simultaneously a violent stretching action is carried on, the material required can only be drawn from the inside of the bar, and thus a hollow space is formed.

Instead of this peculiar arrangement of disks a conical, or rather conoidal, pair of rolls, which amount to the same thing as the disks, considered as joined together, may be provided. It follows that a bar or rod of suitable dimensions which is passed through the Mannesmann rolls will, provided its substance is sufficiently homogeneous and plastic, undergo a violent twisting and stretching action, the fiber being spun as is the fiber in a rope, on account of which the process may appropriately be called a torsional process. The bar in its passage through the rolls is twisted as thread is twisted in a spinning machine. As, however, it cannot be fed from the outside as is the thread, and, as has been said, the diameter cannot be reduced on account of the action of the rolls, it is forced to draw on

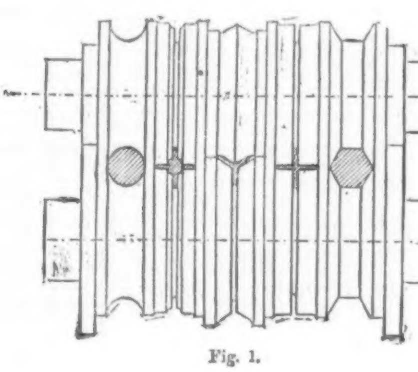


Fig. 1.

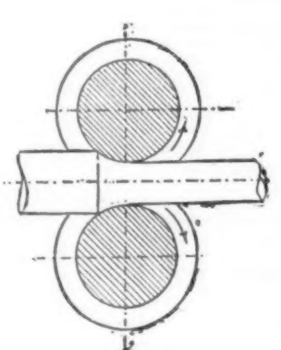


Fig. 2.

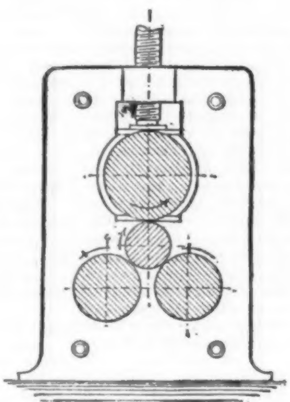


Fig. 3.

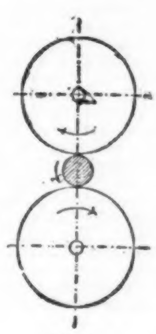


Fig. 4.

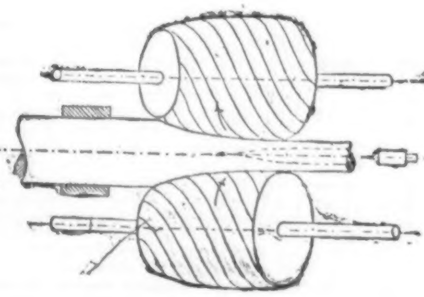


FIG. 5.

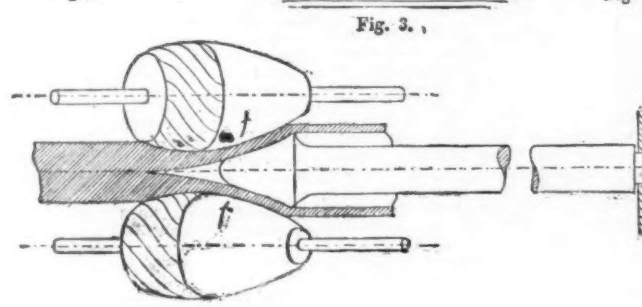


FIG. 6.

ROLLING SEAMLESS TUBES.

* Paper read before Section G of the British Association at Bath.

the interior for a supply of material. I will attempt to explain in another way.

The tube is made thus: A bar is placed between the conoidal rolls at the part where, their diameter being least, the speed at which they move to make a revolution is also least. The rolls seize the bar and draw it into contact with parts of the cones which move more and more rapidly, though, owing to the way in which the rolls are set, the space left between them for the passage of the bar decreases slightly. Slight, however, as is this decrease in the space between the rolls, a certain amount of material has to be shifted. The action of the rolls prevents this material from being taken from outside of the bar, and consequently it is drawn from the interior—hence the hollow, hence the tube. Soon after entering the rolls a small central fracture is formed which widens out to a hollow space as the increased stretch is made to take effect in an increased twist acted on from the surface.

The increasing twist of the fiber of the bar while passing through the rolls and the peculiar relation kept up between longitudinal and turning action is the characteristic of the Mannesmann tube-rolling machine, and this action it is that enables it to make a tube from a solid bar or ingot.

Though the bar is thus converted into a tube by the action of the rolls, and their action only, a mandrel is generally used to finish and smooth the interior and enlarge the tube. This use of the mandrel has led to the erroneous belief that it is necessary to form the hole in the bar. No machine, however, could stand the strain if it were attempted to force a mandrel longitudinally through a solid bar of hot steel. Such an operation is impossible. Just sufficient power is used to form the hollow in the bar from the action of the rolls on its outside, and into this hollow the mandrel enters, smooths the inside, and, when required, enlarges the tube. Thus we have the strange experience in rolling that by one operation the bar is made hollow and also longer and wider than when it entered the rolls a few seconds before.

In a specimen placed before you is the proof that the hollow in the interior of the bar is formed without the intervention of a mandrel. This piece in its present shape is obtained by interrupting the action of the rolls while the bar is still on its way through them, and then breaking off the bar so as to expose that part where the hollow is just commencing to form. This piece is sound in its solid part as well as in the hollow part, and the inner surface of the commencing tube is crystalline. This shows that no mandrel can have acted on it. Besides this, the inner surface is not oxidized as it would have been if it had been exposed to the air at a red or white heat. The bright surface is preserved because no air need enter the tube during formation. Until such a specimen as you have before you is cut open a vacuum exists in the interior, both ends being hermetically closed. Such a specimen is made by slightly pointing the bar at the two ends, so that they escape the full action of the rolls at its entry and exit.

This curious result can always be obtained, and it quite disposes of the allegation that the hole is made by a mandrel. The specimen shows also both how the tube in the center commences by a fracture of the metal and widens out, and also the twist of the fiber is seen, which has the appearance of a rope. This peculiar twist of the fiber assists in giving the tubes their great toughness and resisting power. The various specimens put before you are mostly produced from the relatively cheap open hearth steel. The Mannesmann process in shaping metals upsets most of the hitherto accepted ideas and conditions, inasmuch as, instead of avoiding any twist of the fibers, it by one operation gives the greatest possible twist to the fiber with a corresponding stretch of material. It, moreover, as I have already said, may, assisted by a mandrel, increase the outer diameter of a bar instead of diminishing it, as do all other rolling mills. The tube produced by the Mannesmann process is generally greater in diameter than the bar from which it is formed. The child is at its birth larger than the parent.

From this description and the facts here attempted to be given, it is evident that we have in the Mannesmann process a system of rolling as new as it is capable of producing effects hitherto not contemplated. In combining all the various systems of rolling as described above, it may claim to be called the universal system of rolling, in which all hitherto known rolling processes represent a part. The old polishing and straightening machine could never, it is evident, produce like results, because the essential constructive conditions are wanting. It is remarkable that not only competitors, but otherwise competent men, rejected the Mannesmann process as either not new or as being wrong in principle and generally impracticable, and this sweeping condemnation was suported by arguments apparently logical and sound. I trust this short explanation of an intricate and novel process, and I may say principle, of rolling tubes from solid ingots may assist in dispelling the incredulity and prejudice that has grown up around it. In face of the numerous possible applications of the process, great difficulties may yet have to be mastered, but it may be safely foretold that these will mostly be overcome on account of the true principle on which the process is based and by the energy and intelligence that have conducted it to its present advanced state.

DRY PLATES.*

By G. CRAMER.

SINCE the introduction of the dry plate into practical use, about eight years ago, the process has been brought to such a state of perfection that all its branches are now almost universally understood. Plates are now made which combine a very high degree of speed or sensitiveness with all other good qualities. Pictures are now produced with the minimum of exposure, and with higher grade of perfection than was possible with the collodion and silver bath, as can easily be verified by the specimens of beautiful work shown at our photographic conventions.

The photographer of to-day can hardly imagine the troubles of his brethren in the olden time; for instance, in making copies, sometimes requiring ten to twenty minutes' exposure, or taking views outside of the studio, or making pictures of restless children, family groups, etc.

But even if the process has been reduced to simplicity itself, there is always room for the true artist to show his superior skill and taste, and he will produce a picture which will bear criticism, where another one, not so gifted, will with the same material make but a mediocre piece of work.

It is admitted that the more sensitive the plates, the more must they be guarded against injury by improper light, or too much light while developing, and that a very rapid plate does not permit any careless manipulation.

Forcing the development with solutions strong in alkali is detrimental to the beauty of the negative, and does not accomplish its intended purpose of making up for insufficient exposure. Mild treatment is always to be preferred, and whenever the clearness of a good plate is affected it is proof that the plate has been either light-struck or that the developer is too warm or too strong in alkali.

Strength and temperature of the developer being of the greatest importance, it is evident that the developer should be used cold and more diluted in summer, while in winter or in cold weather it can be used stronger and warmer, on account of the liquid cooling rapidly in the cold dishes and cold atmosphere.

The alkali now mostly employed is the carbonate of sodium, which, if judiciously used with pyro and sulphite of sodium, has thus far been unexcelled as a developer for dry plates.

The newly recommended hydrochinon has not yet been proved to have any advantage over this simple developer, either in rapidity or fine printing quality.

That the amount of pyro used regulates the intensity, and that the color of the negative can be regulated at will by the use of more or less sulphite of sodium, are facts now so well known as to need no further explanation.

Strengthening of negatives should be avoided as much as possible by carrying the development far enough, as it is easier to reduce than to intensify a negative.

For reducing intensity the combination of red prussiate of potassium and hyposulphite of sodium has no superior. In order to insure durability of the negative and to avoid stains, the necessity of thorough fixing and the frequent change of fixing bath is urged by all authorities.

The great annoyance in the past of frilling or softening of the films, which caused the loss of many negatives, and especially so in hot climates, can be entirely avoided by using cold developer and a fixing bath containing an equal amount of alum and hypo; as after passing through this bath the film is perfectly hardened, and the negative can subsequently be washed even in warm water.

Different systems of marking the plates with numbers indicating their sensitiveness are used, but owing to the fact that there is no unchangeable standard of light by which the sensitiveness can be measured accurately, and that under certain conditions the plates gain considerable in speed with age, no positive reliance can be placed in these numbers, and the only safe guide to ascertain the speed of the plate exactly is actual trial.

In the short time of its existence, the dry plate has revolutionized the art of photography, and made possible that which in the wet plate days was impossible.

Keeping abreast with the spirit of our century, the dry plate will be found prepared to satisfy the demands of science and the arts so far as human brain and ingenuity can do it.

COLLODIO-BROMIDE EMULSION FOR TRANSPARENCIES.*

I HAVE been induced to come forward on this occasion, and show the process of making and using collodion emulsion, as it appears to me that the process has almost entirely escaped the notice of amateurs in this country; and as the process is one peculiarly adapted for use in hot climates, I trust that the short description I am about to give of it will induce some more competent members of our society to take it up and show us what can be done with it.

The formula on which the process as shown by me is based was originally given to me by one of the leading amateurs in London, and the developing and other formulæ are the result of my inquiries and experiments. The plates made by this formula would be considered as very slow indeed by any one who only has experience of the modern rapid gelatine plate, but although they are so slow, the exposure for contact transparencies is only two to five seconds with a clean, bright negative and diffused daylight.

Plain Collodion.

Alcohol, methylated	4½	drachms.
Ether	3½	"
Gun cotton—high temperature	12	grains.

Bromide Solution.

Alcohol, methylated	1½	drachms.
Distilled water	20	minims.
Ammonium bromide	13	grains.

Silver Solution.

Distilled water	13	minims.
Silver nitrate	20	grains.

It is generally considered that the most important point in the whole process is to obtain a suitable quality of pyroxyline, and when this has been got, the rest is comparatively easy. It is advisable, on getting suitable pyroxyline, to make a stock of plain collodion and let it rest for some time, so that all insoluble particles and other impurities may sink to the bottom; tall, narrow bottles are best to store it in. The proportion for a stock may be: Alcohol, twenty-two ounces; ether, eighteen ounces; pyroxyline, one ounce. The bromide should be dissolved in the given quantity of water made almost boiling, and the alcohol should not be added until the solution has got quite cool again. The silver may be readily dissolved if the water be warmed.

To make the emulsion, pour the one ounce plain collodion into a clean four ounce bottle with glass stopper, then add the bromide solution, shaking well for some minutes; the bottle containing the bromized collodion should then be taken into the dark room and the silver solution added little by little, shaking well between each addition. It is well to rinse out both the bromide and silver bottles with a little of the collodion to insure the whole of the salts being taken up. The emulsion should then be kept in the dark for about twenty-four hours, shaking well at frequent intervals, and when ready for washing it should be poured into a glass dish, which should be large enough to contain the quantity of emulsion in a mass not thicker than one-eighth of an inch; as the solvents evaporate a skin forms on the surface, which should be broken up occasionally with a silver spoon or an ivory paper knife. When the solvents are completely evaporated, the pellicle should be washed in frequent changes of distilled water for half an hour or so, until all the soluble salts have been removed. The pellicle should then be squeezed in pieces of clean calico until as much as possible of the water is removed, and it can then be dried by moderate heat over a water bath. The whole of the washing process must be done in the dark room or at night time by the light of a candle placed at some distance.

When quite dry the pellicle may be redissolved in three-quarters of an ounce of alcohol absolute (0·805) and three-quarters of an ounce of ether sulphuric pure (0·720) (pouring the ether on first); and when all the pellicle is dissolved, the bottle (a four ounce one) should be well shaken up, and in about twenty minutes to half an hour the emulsion will be ready to coat plates with, after being carefully filtered.

The plates (three and a quarter inches square for choice) should be very carefully cleaned in the following way: First, soak them in dilute nitric acid (acid one part, water ten parts), then rinse them in plenty of clean water, drying them with a clean cloth. They should then be polished on both sides with a cleaning solution (say Tripoli power mixed with methylated spirit and a little ammonia), after which they may either be edged with India rubber solution to the extent of one-eighth of an inch all round, or they may be dipped in a hot solution of gelatine (twenty grains to twenty ounces water) and dried with a clean cloth.

The filter for the emulsion may be merely a small funnel with a little tuft of cotton jammed in it, through which a little alcohol should first be run, or, what is better, the first portion of emulsion running through may be returned to the filter.

Before coating a large number of plates, it is advisable to try whether the emulsion is in good working order and free from fog; to do this, coat a plate with the emulsion, and as soon as it is well set, wash it in clean water until all the alcohol and ether are washed out, then pour over it a little developer of full strength, and after letting it remain on the plate for a few minutes wash well and fix it; this, of course, should all be done in the dark room and the plate should fix out perfectly clear and free from fog or stains. If stains are present, the cause is generally dirty plates (that is, they are not chemically clean); but if fog is present, a drop or two of an alcoholic solution of iodine will effect a speedy cure. If the latter addition be necessary, the emulsion must be well shaken up again and allowed to rest for half an hour before refiltering and coating plates.

To any one who has worked the wet process, it will be easy to coat plates with the emulsion; but as very many of those belonging to the society are probably only acquainted with the modern gelatine plate, a short description may be useful.

After securely fixing a pneumatic holder to the back of the plate, dust the top surface with a flat camel hair brush and pour on the center of the plate a pool of emulsion that will cover about one-fourth of the whole area; let the emulsion run to the right hand far corner, then to the left far corner, then to the left near corner, and finally pour off the surplus by the right near corner into the filter; the plate should then be raised to an almost vertical position and rocked vigorously to and fro to prevent markings; when the emulsion is apparently set and no more drops from the plate, it may be put into a grooved rack to dry spontaneously, or laid upon a flat surface and dried by gentle heat, say 150°.

A few dozens of plates may be coated in a very short time, and they will keep very well for a considerable time.

Transparencies may now be made on these coated plates either by contact or in the camera; by contact, using a clean, bright negative (like the one now shown), with diffused daylight the exposure need only be from one to four seconds; in the camera the exposure of course depends upon the amount of reduction and the stop used in the lens, so that it is almost impossible to give any safe guide, but I may say that using a Ross' rapid symmetrical lens, full aperture, a clean, bright negative, 6½×4¾, to be reduced to three and a quarter inches square, and using the clear sky as a background, the exposure may be anything from two to six minutes. When making slides by reduction in the camera, the plates may be exposed as soon as coated and the emulsion set; there is no need to wait until they become dry, as they are put in a dark slide, and the surface, therefore, does not get injured in any way.

The longer the exposure, the warmer in color will be the resulting picture. Short exposures and full strength developer give black, cold tones, but full exposures with diluted or restrained developer give almost any color from brown to ruby, and these warm colors can be subsequently modified to any extent in toning.

Too much care cannot be exercised in handling these plates, the surface being very much more delicate than that of the ordinary gelatine plate. The negative must be very carefully dusted with a flat brush, and then the plate must be laid directly on the negative in the printing frame, taking care that while fastening the springs no sliding or rubbing action takes place. The printing frame shown herewith has some new fastenings which obviate the risk of rubbing when putting the springs into action. The springs also should not be so strong as in the ordinary printing frame.

The developing solutions may be made up as follows:

Stock Solutions.

1.

Pyrogallic acid	96	grains.
Alcohol, methylated	1	ounce.

* Read before the Minneapolis convention, July, 1888.

* A communication to the Amateur Photographic Society of Madras.

2.

Carbonate of ammonia	160 grains.
Potassium bromide	5 "
Acetate of soda	10 "
Distilled water	3 ounces.

Or, 1*a*.

Pyrogallic acid	1 ounce	Faintly acid with citric acid.
Sulphite of soda	4 ounces.	
Distilled water	9 "	

2*a*.

Liquor ammonia	1 ounce.
Bromide potassium	2 ounces.
Water distilled	9 "

To develop, first soak the exposed plate in dilute methylated alcohol (two spirit to one water), and then wash off the spirit with plenty of clean water; the working developer may be made up thus, either

1	15 minims	or	1*a*	40 minims.
2	2 drachms	"	2*a*	10 "
Water	2 "	"	Water	3 drachms.

A very little developer is sufficient if the plate be held in the hand, one drachm easily developing a plate three and a quarter inches square; if fully exposed the developer may be diluted with another drachm or two of water; the image soon makes its appearance and rapidly develops up to full density. When there is any sign of veil coming over the high lights, wash off the developer and fix in potassium cyanide, twenty grains to the ounce of water, and well wash for half an hour.

It may be as well to mention that potassium cyanide is a most deadly poison (two grains being a fatal dose), and that it is not necessary to keep the dish with this solution in the dark room; if the plate be well washed after developing, it may safely be taken outside the dark room and dropped into the fixing solution, which may be on a table out in the open air; bad headaches will therefore be avoided.

After fixing and well washing the plate may be examined; and should any veil appear on the high lights, clear it off by soaking the plate for three or four seconds in a solution made by taking a few drops of an alcoholic tincture of iodine and adding to them distilled water till the solution is the color of pale sherry; again wash and return to the fixing dish. If still not quite clear, do it again and again if necessary—then wash well.

To tone the transparency, take

Platinum tetra-chloride	1 grain.
Nitric acid	1 minim.
Water	4 ounces.

and immerse the plate. Watch carefully, as the toning proceeds very rapidly. As soon as the wished-for color is produced, take the plate out at once and wash well and quickly. Should the toning have gone too far, the warm color may be restored by flowing again over the plate the alkaline developing solution and the toning done over again more carefully. Should the picture appear too thin after toning, it may easily be intensified to any degree by the following solution:

Pyrogallic acid	30 grains.	To each drachm of this add two or three drops of a twenty-grain solution of silver nitrate.
Citric acid	30 "	
Alum	30 "	
Distilled water	15 ounces	

Should the picture appear too dense after toning, it may be reduced by flowing again over it the fixing solution.

After any of these operations the plate should be well washed, and when quite finished and dried in a place free from dust, it should be varnished with a clear, pale varnish which should be carefully filtered through tissue paper or cotton wool. The final operation for a lantern slide is mounting it in contact with another clean glass of the same size, putting a suitable mask between them, and binding the edges with strips of black paper.

Mounting a lantern slide requires some consideration, and each slide should be mounted in a mask that is specially suited to show off the artistic beauties of the picture. It used to be the custom to mount all lantern slides with a circular or cushion-shaped opening, but this was only done on account of the practice of using two lanterns for dissolving, so that it was then necessary to have all the pictures with openings of the same shape and size in order to get the views to register correctly on the screen. Now, however, that single lanterns with slide holders capable of very rapid changes are more in vogue, there is no need for such conservatism, and I would advise every one to make and mount his slides with masks of the size and shape best adapted to each particular view.

It is also usual to put on the front of the slide one or two white spots of paper at the top, and then on putting the slides into the holder of the lantern these white spots will be at the bottom next to the condenser.

The name of the picture may be written on the mask (before mounting) in Chinese white, or a slip of white paper may be gummed on the front outside and the name written in black ink. Whatever plan any one may adopt for marking his slides, it is advisable for each to stick to one and the same plan for all his own slides, and then less trouble is likely to occur if a stranger is showing them in the lantern. I think I have now given details of the whole process from beginning to end; but if any one tries it and gets into difficulties, he has only to refer to me, and I will do my best to help him. FRED. DUNSTERVILLE.

Rayapuram, Madras.

—*Reported in British Journal of Photography.*

THE SAFETY OF COMMERCIAL KEROSENE OILS.

By SPENCER B. NEWBURY and W. P. CUTTER.

A SERIES of experiments were made by the writers a year ago for the purpose of determining the maximum temperature reached by the oil in the reservoirs of the most powerful modern oil lamps. A brief outline of the results of these experiments was published in the SCIENTIFIC AMERICAN SUPPLEMENT, July 16, 1887. The writers found that the oil in modern lamps often reaches a temperature of 110° to 112° F., and strongly urged the use in these lamps of oil having a high flashing point, in order to avoid danger of explosion.

The legal regulations in regard to the flashing point of illuminating oils vary greatly in different parts of the country, certain States having no statutes on the subject, others requiring that no oils shall be sold which do not reach a certain standard of safety. In New York State no oil is allowed to be sold which flashes below 100° F. when tested in the manner prescribed by law, in the instrument known as the New York State tester. Most of the prevailing legislation upon the subject is probably based upon the observations of Dr. C. F. Chandler, who sixteen years ago made a careful study of the question of the safety of burning oils.* Dr. Chandler found that the oil in the lamps generally in use at that time, while burning in rooms at ordinary temperature, rarely reached 100° F., but nevertheless recommended the adoption of a legal standard of flashing point not lower than 120° F. In this connection he says:† "The point of 100° F. does not seem high enough to secure immunity from danger, though it may be said that very few, if any, accidents occur with oil which does not flash below this temperature."

If the standard of 100° was too low to afford protection with the old fashioned single wick burners, it must be far more inadequate at the present day, when lamps are everywhere in use which raise the oil in the reservoirs to a point fully twenty degrees higher than that reached in the lamps which Dr. Chandler tested. In modern oil lamps with double wick or circular burners the oil, while the lamp is in use, is often, probably generally, heated above its flashing point. It is evident, then, that the danger of explosion is constantly present while using these lamps with ordinary oils, unless, indeed, some other cause than temperature may contribute to the safety of oils which flash above 100°. It is not proved, for example, that the vapor of such oils can, at any temperature, form violently explosive mixtures with air. So far as previous experiments have shown, kerosene explosions may be due to the presence in oils of low flashing point of small quantities of very volatile or gaseous hydrocarbons. These constituents may be absent in oils of high flashing test. These latter may therefore not be capable of exploding. In short, no clear statement has yet been made of the relation of the flashing point of oils to their capability of giving violent explosions with air. It was in the hope of establishing such a relation, and thus determining the value of the flashing point indications as a guarantee of safety, that the experiments described in this paper were undertaken.

The questions which presented themselves for study may be briefly stated as follows:

1. Will all the hydrocarbons of which burning oils are composed, when diffused in air in proper proportions, yield distinctly explosive mixtures? If so, at what temperature for each?

2. What are the most volatile constituents of ordinary kerosene, and how do the proportions of each of these lighter hydrocarbons affect the flashing point of the oil?

It is well known that it is difficult to produce explosive mixtures of gases at will; the experiment of exploding marsh gas with air requires very careful adjustment of proportions, or no explosion results.

A series of hydrocarbons of nearly constant boiling point was obtained by careful purification and repeated fractional distillation of lighter petroleum-products. The distillation was accomplished with the aid of a long Hempel tube. In testing the possibility of producing explosions with air with the several fractions, a strong glass cylinder 30 cm. high and with a capacity of 300 c. c. was employed. This was immersed nearly to its mouth in a water bath, by means of which the experiments could be made at any desired temperature. The amount of each hydrocarbon which could be completely burned by this volume of air was calculated, and the corresponding quantity of each fraction weighed out in a thin glass bulb about ½ cm. in diameter. When a test was to be made, a little mercury was placed in the cylinder, the little bulb of hydrocarbon introduced, and the cylinder closed by a well-fitting stopper. By shaking, the bulb was then broken and its contents diffused throughout the air in the cylinder. The explosiveness of the mixture was tested by cautiously removing the stopper and applying a small flame to the mouth of the jar. The experiments were made with varying qualities of each hydrocarbon, and at different temperatures. It was found that the most violent explosions were obtained by the use of nearly the amount of the hydrocarbon which could be completely burned to water and carbon dioxide by the volume of air in the cylinder. It was shown at once, moreover, to the surprise of the experimenters, that sharp explosions could be obtained at ordinary temperatures with hydrocarbons of comparatively high boiling point, as for example with heptane, which boils at about the same point as water. The following table gives a summary of the results obtained:

Hydrocarbon	Formula	B. P.	Source.	B. P. of Fraction	Temperature at which explodes with air.
Butane	C_4H_{10}	1° C.	C_2H_5I and sodium.	1° C.	Ordinary.
Pentane (Iso)	C_5H_{12}	30°	Petroleum ether.	30°	"
Hexane	C_6H_{14}	66°	Petroleum ether.	67-68°	"
Heptane	C_7H_{16}	98·5°	"Abietene" (*Pinus Sabiniana.*)	98·5°	"
Octane	C_8H_{18}	124°	Illuminating oil	125-130°	"
Nonane	C_9H_{20}	149·5°	" "	148-150°	Between 150° and 212° F.
Decane	$C_{10}H_{22}$	161° (?)		160-165°	Between 150° and 212° F.

Nonane and decane could not be made to explode with air at temperatures under 150° F., but by heating the bath to 212° F. distinct explosions were obtained. As these hydrocarbons seemed to mark the limit of the constituents of a safe oil, experiments were made under conditions similar to those which prevail in a burning lamp. A cylindrical copper vessel of about 300 c. c. capacity was employed, provided with a loosely fitting cover through which a hole about $\frac{3}{16}$ inch in diameter had been bored. This was charged with a few drops of the material to be tested, and gradually heated in a water bath, a small flame being applied to the orifice from time to time, as in the ordinary method of testing oils. The point of explosion was shown by a distinct puff which threw off the cover of the vessel. The results were more definite than those obtained by the use of the glass cylinder, and show that the legal limit as to flashing point lies between these two hydrocarbons.

Nonane exploded sharply at 79° F.
Decane " " 104° F.

A sample of illuminating oil which showed a flashing point of 111° F. by the New York State tester gave, when tested as above, a distinct explosion at that temperature, 111° F.

The above experiments lead to the following conclusions:

1. All the paraffines up to decane, and probably also higher members of the series, may at suitable temperatures form explosive mixtures with air.

2. Oils which flash at a point considerably above the legal requirement may, under proper circumstances, give violent explosions at their flashing temperature.

3. An oil consisting of pure decane, $C_{10}H_{22}$, would be accounted a safe oil by the legal flashing point test of New York State, while one consisting of nonane would be below the standard.

In order to determine what are the lowest hydrocarbons present in ordinary burning oil, a sample of commercial "water white" oil of excellent quality, showing a flashing point of 108° F., was carefully distilled, at first in a vacuum, and the lighter portions repeatedly fractionated by means of a Hempel tube. Two kilogrammes of oil yielded 30 grammes of a distillate boiling at 110°-130° C., which on further rectification proved to be chiefly octane; and 100 grammes, boiling at 130°-160° C., which appeared to consist principally of nonane and decane. Only traces of hydrocarbons of lower boiling point than octane were present. The addition of 5 per cent. of heptane to a sample of this oil lowered the flashing point to 97°. A specimen of "mineral sperm" oil which flashed above 212° F. was treated with different proportions by weight of pentane, hexane, and heptane, and the reduction of the flashing point noted.

MIXTURES OF MINERAL SPERM OIL WITH LIGHT HYDROCARBONS.

Mineral	sperm	oil	95	per	cent.,	pentane	5	per	cent.,	flashes	110° F.
"	"	"	90	"	"	"	10	"	"	"	ord. temp.
"	"	"	95	"	"	hexane	5	"	"	"	110° F.
"	"	"	90	"	"	"	10	"	"	"	ord. temp.
"	"	"	95	"	"	heptane	5	"	"	"	145° F.
"	"	"	90	"	"	"	10	"	"	"	110° F.
"	"	"	85	"	"	"	15	"	"	"	96° F.
"	"	"	80	"	"	"	20	"	"	"	ord. temp.

It is evident, therefore, that the low flashing point and danger of oils may be due not to the presence of small quantities of very volatile products, but rather to the large proportion which they contain of constituents of moderately high boiling point.

The burning test, which determines the temperature at which a sample of oil may be set on fire and will burn in an open vessel, has been generally conceded to be unreliable as an indication of safety. Nevertheless, the laws of New York State prohibit the sale of oil which burns below 300° F. An oil may show a very high burning test and yet be of low flashing point and therefore extremely unsafe. This is especially the case with oils which consist of a mixture of very heavy and very light hydrocarbons. The more nearly homogeneous an oil is in composition, the closer the flashing and burning points will approach each other. For example, the fractions corresponding to nonane and decane used in the experiments described above take fire at a temperature but little above their flashing points.

Nonane flashes 79° F., burns 110° F.
Decane " 104° " " 136° "

The flashing point of an oil is also, as is well known, dependent not only on the proportion of light constituents present, but upon the character of the oil as a whole. An unsafe oil may be brought up to a legal standard by adding to it a sufficient quantity of heavy lubricating oil, but such a heterogeneous mixture will be of poor quality for burning purposes. It is doubtless this which has led manufacturers to make the oft-repeated claim that a high flashing point is inconsistent with good burning qualities. If refiners would be content to make a little less oil, leaving out some of the benzine and some of the lubricating oil as well, there would be no difficulty in producing illuminating oils of high flashing point and excellent illuminating power. The well known Astral oil, which flashes at 125° F., is a standing protest against the claim of superior burning qualities for low grade oils. This is simply the *heart* of the burning oil freed from both lighter and heavier deleterious ingredients. Tests made by the authors have shown that the above mentioned brand burns admirably in modern lamps, and by photometric tests gives results fully equal to any other oil in the market.

We are at present engaged in a series of experiments to determine the relative value as illuminating agents of the different hydrocarbons composing kerosene. The results of these experiments will form the material of another communication.

Only a very small amount of volatile material requires to be removed from an oil of ordinary character in order to raise its flashing point materially, as the following experiment shows.

One kilogramme of an oil flashing at 108° F. was placed in a flask, and a gentle current of air at ordinary temperature aspirated through it during 24 hours. At the end of that time the oil was found to have lost 28 grammes or 2·8 per cent. in weight, and showed a flashing point of 116° F. Treatment of ordinary oils by a somewhat similar process would doubtless be effective in making them materially safer, and would probably add but a fraction of a cent per gallon to their cost.

It would be too much to expect of refiners that they should furnish oils of much higher flash test than they are required to do by law. The passage of a statute raising the legal standard to 120° would, however, cause no serious hardship to manufacturers, and would effect a saving of life and property which would far outweigh the very slightly increased cost of burning oil. It has been urged that with such a law manufacturers would simply add heavier products to their oils and thus bring them up to the legal standard, to the detriment of their burning qualities. This would, however, be in opposition to their own interest, since oils of high flash

* *American Chemist*, Aug., 1872, 43.

† *Johnson's Encyc.*, "Petroleum," 227.

and excellent quality are already in the market and are extensively used.

The experiments described above show conclusively that an oil heated above its flashing point is dangerous, whether that point be high or low. There can, therefore, be no doubt that in using kerosene of ordinary quality in the powerfully beating lamps which are now common, we are dependent for our safety upon the accurate construction of the burners, which renders it difficult for the explosive vapors in the lamp to become ignited. An oil which flashes below 120° F. is not safe to use in these lamps, and with oils of ordinary grade the conditions of explosion are constantly present.—*Amer. Chem. Jour.*

THE STORKS OF ALSACE AND THE FAUNA OF STRASBOURG CATHEDRAL.

LIKE the Coliseum of Rome and the ruins of the Cour des Comptes at Paris, the Cathedral of Strasbourg has a flora and fauna of its own worthy of the attention of naturalists. Without counting the stork, the temporary tenant of the neighboring chimneys, eight species of birds nest upon the antique structure, where four of them remain the entire year. To these must be added, for the fauna, three or four species of bats, the common mouse and the church rat, a butterfly, some spiders, and a few ants, while the local flora of the dressed stones is represented by some twenty microscopic lichens. Upon well exploring the edifice in every nook and crevice, from the foundation up to the roof, and to the point of the bell turrets, one will find more than one species to add to the list of this station which Mr. Ferdinand Reiber has prepared for the *Bulletin* of the Colmar Natural History Society, in which he has also published the fauna of the Strasbourg waters—a remarkable work by Baldner, a fisherman-naturalist of the seventeenth century.

FIG. 1.—A STORK'S NEST OPPOSITE STRASBOURG CATHEDRAL.

The reproduction of a few instantaneous photographs of storks (Figs. 1 to 4), taken by Mr. Schweitzer on a roof near the cathedral, leads us to cast a glance at this curious zoological station. Among the sedentary birds living here in every season may be mentioned the kestrel, the barn owl, the domestic sparrow, and the common pigeon, to which may be added, as transitory guests, the jackdaw, the chimney swallow, the martin, and the redstart. The stone cone, which rises boldly to 465 feet above the present pavement of the city, is the rendezvous of thousands of insects that wander in the air. The spire of the cathedral seems to attract these winged creatures like a gigantic beacon, and just as a light at night attracts small winged animals.

The white stork (*Ciconia alba*), arriving in Alsace in the month of March, the precursor of spring, nests both upon trees and the top of buildings. We have seen them rearing their brood upon trees at but a few yards above the ground, in the meadows along the Sauer. Upon high buildings they are safer, and they find, too, upon the tops of roofs material for their nests prepared by the solicitude of the bourgeois owners. A bird venerated by the Alsatians almost to the same degree as the ibis in ancient Egypt, the whole population protects the stork with a jealous solicitude. The arrival of the first couple of storks was formerly announced in our Middle Age cities by the sound of the trumpet. Popular belief still attributes to the bird the gift of bringing good luck to the house on which it builds its nest, and of protecting it against lightning. To the young maiden who sees the long-legged bird walking toward her, it is a sign of her near betrothment. The Strasbourg children are told by their mothers that the storks bring them little brothers seated behind upon a saddle of feathers and holding on by the bird's neck.

Hunters, not so well disposed as the common folk, have a grudge against the greedy stork because it swallows young leverets, just as if they were simple mice and frogs. However, woe be to the unlucky ones who are prompted to discharge a shot at the body of their competitor on stilts. Public reprobation will severely stigmatize such a misdeed, and in certain Swiss cantons in past times the act would have been assimilated to the murder of a man. At the time of their passage, flocks of white storks are seen sitting by thousands upon the oaks of the forests of Reichstett, near Strasbourg, in order to spend the night, and afterward to continue their voyage along the Rhine, toward Holland, probably. Those that remain with us come in couples to select the old nests that are disposable upon the roofs or chimneys. The right of first occupancy seems to be admitted in the habits of the stork as guarantee of the domicile. Nevertheless, this right of usage sometimes gives rise to disputes, for couples are sometimes observed to engage in fierce combats for the possession of the same nest. During their entire stay, during the incubation and rearing of the young family, the birds hunt in moist meadows and marshy places. The quantity of small animals—frogs, toads, mice, slow-worms, adders, etc.—that these hunters, however lean they be, swallow is prodigious. In the course of August, when autumn is approaching, they leave the country in order to secure their food in more southerly climes during the winter season. The black stork (*C. nigra*), which is indigenous to the wooded marshes of Eastern Europe, appears but accidentally in Alsace.

The natural history of the Alsatian stork is too well known to recount it here in detail, and, this being the case, we shall limit ourselves to the statement of two facts, observed at Strasbourg and Colmar, that will contribute to the study of the habits of this species. At Colmar, the watchman of the tower of the church St. Martin tells us that, in the brood of a recent year, the storks domiciled on the ridge of the roof discovered one fine morning a bird of a different species that had been hatched in their nest from an egg laid by a bird of passage. The male, at the sight of this product foreign to his lineage, not only did not find it opportune to adopt it, but cast it out with undoubted signs of bad humor. Much more; perhaps suspecting infidelity on the part of his mate, he applied a wholesome correction by strong blows of his bill. Upon the flat roof of the Strasbourg Cathedral there was quite recently witnessed a fight between some kestrels dwelling on the roof and a stork of the vicinity. The latter, hovering over the city, was assailed by two kestrels. The couple were evidently making the attack in order to display their skill, for they could never have possibly carried off so large a bird. The rapacious birds alternately pounced upon the absurd wader, who would only have had to take refuge upon a roof to defy the attacks of his adversaries. The kestrels became excited, and brought the stork back and kept him always in the same aerial circles. This sport lasted a long time and attracted a host of spectators upon the Ill Bridge. All at once the battle ceased in an unexpected manner. At the moment when one of the adversaries was pouncing upon the stork, the latter perforated its abdomen with a blow of his bill. The wounded bird immediately uttered its well-known cry of *cri-cri-cri*, and flew toward the cathedral with a string of entrails hanging between its feet. Its companion also then deemed it prudent to retire from the field. As for the stork, who was now delivered from his enemies, he at

FIG. 2.—A STORK BEGINNING ITS FLIGHT.

FIG. 4.—A STORK'S NEST ON A ROOF.

FIG. 3.—A STORK LEAVING ITS NEST.

AN ECLIPSE OF THE SUN AS SEEN FROM THE MOON.—BY WILHELM KRANZ.

once alighted upon a roof, and, with outstretched legs and partially open bill, gave every sign of intense excitement.

The kestrels (*Falco tinnunculus*) of Strasbourg Cathedral nest upon the cornices as well as in holes in the wall. Upon visiting the upper galleries of the building, we see the birds sitting upon eggs laid upon the bare stone on the edge of the precipice. For food, they are not content with insects and field mice, but are likewise fond of the chaffinches and goldfinches of city gardens, the sparrows that take refuge under roofs, and even adult pigeons. These birds hunt over the escarpments of Lake Blanc, just as they do in the plain of the Rhine. There is scarcely a ruined castle in Alsace in which they do not take up their quarters in order to continue their depredations with every security. In the lofts of the cathedral, the barn owl (*Strix flammea*) lives alongside of them without being disturbed in its crepuscular habits. Some twenty couples of jackdaws, too, lay their eggs upon the dome at every return of spring, and, in summer, scatter with their young ones, in company with other species of ravens. As long as the new brood cannot fly away, the parent birds are compelled to make tiresome journeys to obtain food for their progeny. The sparrow (*Fringilla domestica*), the chimney swallow (*Hirundo rustica*), and the redstart (*Sylvia tithys*) domicile themselves by preference in the base of the building, in holes, in the cornices, and in the angles of the ogives of every side. As for the martin (*Cypselus musarius*), which arrives at the beginning of May, to depart again in the month of August, that likes to build its nest at the bottom of dark holes, under the stones of the flat roof, or under a large stone covering of very difficult access to the bird. Finally, some domestic pigeons, escaped from cotes in the vicinity, likewise delight to lay their eggs and hatch their young on the heights of our superb cathedral, certain parts of which exhibit genuine deposits of guano.

What life do these eight birds, six of which are very numerous, and which nest together in its various parts, give to the upper regions of the building! Rapacious species and others seem to live in perfect understanding, and respect one another like the cats and dogs of the same house. The noise and movement of the bells do not disturb them. They have no fear, even when the great bell is creating its hubbub. Do not we find here a remarkable case of adaptation, to be considered as a first step toward domestication? Besides these birds, the three genera of Alsatian bats are represented, in the dark reducts of the Strasbourg Cathedral, by several species. If we consider the lower branches, this zoological station offers, after the vertebrates, large spiders of the genus *Epeira*, the webs of which connect all the cornices, small columns, and statues, while pretty little wandering spiders of the family of the *Attides* pursue the insects that have escaped the webs of their large and less active congeners.—*La Nature.*

A SOLAR ECLIPSE AS SEEN FROM THE MOON.

SINCE our sight, sharpened by the telescope, has been able to penetrate the distances of space and to recognize more clearly the special structure of other worlds, the questions have arisen, probably with every observer of any peculiar heavenly phenomenon, How would the heavens appear from a different standpoint, say for instance from the star that we were just admiring. Would our earth be visible from there, and how would it look?

These questions suggest themselves specially when watching a total eclipse of the moon, for the astronomer tells us that it is our earth which is throwing its shadow on its celestial companion, and that we really are the cause of this heavenly display. We understand at once that this would have to be called, on the moon, a total eclipse of the sun, whereas, if there is a total solar eclipse visible on the earth, it is caused by the shadow of the moon, to speak astronomically.

We might ask ourselves, for example, if, on January 28 of this year, when we saw a total eclipse of the moon from our standpoint on the earth, such wonderful phenomena were visible from the moon as the newspaper accounts led us to expect August 19, 1887, but which, unfortunately, we were unable to see on account of the unfavorable weather.

The astronomer, aided by the artist's eye trained to perspective, answers these questions with the accompanying landscape, which places us on our neighboring world just at the time when the shadow of the mother planet is crossing it. The spot on which the picture places us lies about 30° distant from the north pole of the moon, in the neighborhood of the great circular mountain Arestoteles, the high, projecting rocks of whose circular crest we see, at the left, rising to a height of 10,000 feet above the level of the middle ground of our landscape. We find ourselves on a neighboring mountain, one of almost equal height, from which we overlook an area of more than thirty geographical miles. What we see here is not the work of artistic speculation, but is exact truth, with the exception of some unimportant details in the foreground. We have a picture before us such as would have been made by a special artist, if one had been sent to the moon at the time of the last lunar eclipse for the purpose of making an artistic report, and he would have chosen to represent that moment which corresponded to half-past one A. M., January 29, in Berlin.

But how entirely different, how terribly peculiar, the wonderful display appears! In a totally black sky hangs an equally black disk—our earth—surrounded by a reddish aureole—the atmosphere—in which the rays of the morning and evening twilight are reflected as a fiery light. Above, at the right, the rays of the sun are already visible beyond the edge of the earth, for, from our standpoint, the totality of the eclipse has already passed. Although the sun looks just as large from the moon as we are accustomed to seeing it, it appears three and a half times smaller than the disk of the earth, and therefore, in a solar eclipse seen from the moon, the length of time during which the sun is entirely covered is much longer than in a solar eclipse viewed from the earth, for the moon appears to us about the same size as the sun. An eclipse of the sun from the moon can be total for about three-quarters of an hour; from the earth, not more than eight minutes.

In our picture strange phenomena of light are visible around the sun. First, the corona, the silver wreath of light, the strange nature of which can be studied by our astronomers during only the few minutes of totality, and which could be watched continuously from the moon because of the absence of light-absorbing and light-radiating atmosphere.

How differently this heavenly spectacle appears from the moon, our nearest neighbor, as compared with the effect on the earth at the same moment! And the surface of the satellite! How terribly strange it looks in the glaring sunlight or in the deep shadow under the blackest sky! The peculiar ring-shaped mountains, which have been incorrectly compared with our volcanoes, would not awaken our wonder as much as the entirely different effect of the picturesque perspective, which brings out all objects with geometrical exactitude on account of the absence of the atmosphere, showing sharp outlines equally lighted even to the limits of the horizon. Our half shades are produced by the scattered light of the atmosphere, while on the moon they would be caused only by sharp precipices.

The peculiar ring-shaped mountains, which have no equivalent on the earth, are the characteristic feature of the lunar landscape. Scarcely anywhere, except in the region in which we find ourselves, are there mountain chains which can be compared with those on the earth. At the right side of our picture we see such a chain, which has been named the "Alps." It is traversed by a valley, which looks to us like a broad furrow under the row of summits.

If we pass farther to the left of our picture, we soon come to the mountain chain called the "Caucasus," lying partly in the shadow of the earth, which is rapidly moving to the left. We have to think of these shadows as being slightly tinged with red, because they are penetrated by the rays of our morning and evening light. In fact, during the last eclipse of the moon we saw our satellite in this characteristic red light, which was specially intense on this occasion.

Were we witnesses of the event, a moment of which is here represented, the glaring changes caused by the shadow of the earth hurrying with gigantic strides over the rugged surface would terrify us. This impression cannot be caused by the artist. In order that such a display may be followed through all its phases, a so-called "scientific theater" is now being erected in Berlin, in which the changes will be represented by different pictures.—*Illustrirte Zeitung.*

ROSE FRANCOIS MICHELON.

NOTES ON ROSES.

ROSE FRANCOIS MICHELON.

JUST as among men there are always some few who tower head and shoulders above their fellows, whether physically, intellectually, or morally, and are universally considered "great men," so among roses there are some varieties whose claims to be accepted as "great roses" are undisputed. Moreover, as in the world of men, although there are plenty of good and useful, not to say indispensable, members of the community, the number of really great men is small, so, in proportion to the infinity of beautiful roses in cultivation, the really great roses, such as General Jacqueminot, Charles Lefebvre, Marie Baumann, Alfred Colomb, La France, Baroness Rothschild, Louis Van Houtte, Marquise de Castellane, A. K. Williams, Madame Gabriel Luizet, and Ulrich Brunner, are by no means numerous.

It must, however, be admitted that an addition was made to the select list of great roses when, in 1871, Levet sent out Francois Michelon. If any one had ever any doubt as to the magnificence of this variety, they should have been dispelled this season, for it has been emphatically a François Michelon year in the south of England at any rate. The flower, whose pure and brilliant rose color is sometimes marred by a burning sun, was exactly suited by the cool, showery weather, and glorious examples were consequently seen on all sides.

One of François Michelon's great charms lies in the fact that, however large the flowers may be grown, they never appear coarse, their exquisite and refined form, purity of color, and smoothness of petal invariably rendering them attractive; and although seventeen years have now elapsed since its distribution, this beautiful rose is still unsurpassed among pure rose colors.

The plant is a vigorous grower, making shoots often of great length, and by the pale green, thornless wood and large foliage is easily distinguishable among other varieties at any time of year; and while it may be regretted that François Michelon is not a freer autumnal, it cannot, for this one failing, be denied a place among the "mighty few," and will unquestionably rank for many years to come as one of the "great roses."

THE RAINS AND RED RUST ON ROSES.

We wish to give the cold rains their due. They have saved many places from an impending water famine, replenished our cisterns with water, and washed off or drowned out the red rust from our roses. It would be easy enough to balance these advantages without traveling far from the fair field of roses. For the present we will write well of the rain for ridding us of our most formidable foe, the red rust. We cannot tell how it was done. Suffice it to say that once it was here and now it has vanished, and without visible cause, barring the floodings of rain, mostly cold rain. Whether the cold perished it or the wet drowned it out we cannot certainly say. Possibly both had a hand in its removal, the rain being the strongest factor in the matter.

This opinion is formed after much observation and not a few attempts to eradicate rust by artificial means. But nature has done her work more thoroughly and with more effect. True, in some places the white mould has succeeded to the red fungus, and we may not have gained so very much by the change of color. But the roses have been benefited, for mildew is more readily curable than the red rust. The latter in its worst state is, in fact, virtually incurable; whereas every rosarian has his half dozen or more nostrums for the cure of mildew, to say little or nothing of the universal panacea—sulphide of potassium. Besides, the sun may destroy mildew, while it is seldom we have rain enough in the time of roses to drown out red rust. Notwithstanding the drowning of the red rust, few rosarians have any desire to see the like of the closing season again.—D. T. F.

ROSE W. F. BENNETT.

After so much has been said and written against this rose, which when first distributed bore such a high character, it is satisfactory to learn that it still retains its good character with some growers. I recently met a gentleman from America (Mr. J. S. Peterson, of Cincinnati), who is a large cultivator of roses under glass, and he told me that he found this rose one of the best and most profitable to grow for winter flowering. He, however, stated that many of the American growers had discarded it, but considered this was due to the rose not receiving favorable treatment. It appears to be a rose which requires exceptional treatment, and when in the hands of those who know how to grow it, it is undoubtedly a fine rose. This must be evident to

all who have seen the splendid blooms which have been exhibited at various times by its raiser, Mr. Bennett, of Shepperton. Other roses which Mr. Peterson spoke highly of were Catherine Mermet and Perle des Jardins. Perle des Jardins, however, does not succeed well with all growers, but when under good conditions it is certainly a grand rose. Sunset, another rose of similar character, can also be highly recommended.—A.

MARECHAL NIEL ROSE.

The very hard pruning which I gave my plants of this rose early in the summer has been fully justified, the heavy rains having forced unusually strong growth, the roots being outside. Some old wood, stouter than broom handles and cut through, has broken remarkably well, throwing up several stout shoots, now 3 feet and 4 feet in length. Buds worked on shoots which broke from Lamarque stock, a very prolific stock for shoots of that character, have already given some splendid growths, while all over the plant wheresoever hard-pruned a wealth of shoots has broken and will continue to make strong growth for the next six weeks. Happily, such wood under glass withstands severe weather, while it will mature thoroughly. Some persons seem afraid to hard-prune their Marechal Niel roses, and are rewarded annually with small shoots and indifferent flowers. I do not find that, whether on the brier or on Lamarque or Madame Berard, or even on Marie Guillot, there is much difference. The chief cause of such robust growth is doubtless found in the thorough moistening of the soil, which is somewhat stiff, but the roots evidently like it. I have noticed some plants of Marechal Niel on Manetti, but planted inside the house, and they have not made by any means such robust shoots as those on outside borders. While so far reserving every robust shoot, it is evident that considerable thinning will have to be done later. It is worthy of note that while the buds worked on to the Lamarque stock have proved so very active, some worked on strong shoots of Madame Berard stock at the same time have not yet pushed growth.—A. D.

LIST OF GARDEN ROSES.

(The best varieties are denoted by an asterisk.)

Provence.

Cabbage or common	Burgundy
*White Provence	Little Gem

Striped Provence.

*Rosa Mundi

Moss.

*Blanche Moreau *Common Muscosa japonica

Chinese, Bourbon, and Noisette Hybrids.

Blairi No. 3	*Madame Plantier
Coupe d'Hebe	Souvenir de Pierre Dupuy

Ayrshire.

Alice Gray Splendens

Many-Flowered.

*Simplex Grandiflora

Evergreen.

*Félicité-Perpétue

Hybrid Climbing.

*Fortune's Yellow, or Beauty of Glazenwood

Laura Davoust The Garland

Species.

Anemonæflora	*Macrantha
Brunonis	Moschata alba
Clynophylla plena	Pomifera
Indica	Pulverulenta alba
Lucida	*Rubrifolia

Austrian Briers.

Single Yellow (R. lutea)	Persian Yellow
Single Copper (R. punicea)	Harrison's Yellow

Hybrid Sweet Brier.

*Hebe's Lip

Hybrid Perpetuals.

Alphonse Soupert	Gloire Lyonnaise
*A. K. Williams	Glory of Cheshunt
*Anna Alexieff	Henri Ledechaux
*Baroness Rothschild	*Heinrich Schultheis
Boule de Neige	John Hopper
Camille Bernardin	Jules Margottin
Charles Lamb	*La France
Charles Lefebvre, or Marguerite Brassac, or Paul Jamain	*Madame Gabriel Luizet
	—— Nachury
	*Marquise de Castellane
Dr. Andry	Merveille de Lyon
Duke of Edinburgh	Pride of Waltham
*Dupuy Jamain	Princess Louise Victoria
Ella Gordon	Suzanne Marie Rodocanachi
Etienne Levet	
Eugene Appert	Thomas Mills
Florence Paul	*Ulrich Brunner
Garden Favorite	*Violette Bouyer
*General Jacqueminot	

Macartney.

Alba simplex Marie Leonida

Ramanas.

*Rugosa alba Coruscans

Rosa Polyantha Hybrida.

Anne-Marie de Montravel	*Mignonette
*Ma Paquerette	*Perle d'Or
Max Singer	

Perpetual Scotch.

* Stanwell Perpetual

Bourbon.

Armosa	Queen
Madame Isaac Pereire	Souvenir de la Malmaison
Marie Paré	

Noisette.

Aimée Vibert	Narcisse
Céline Forestier	*Ophirie
*Lamarque	Reve d'Or
*Maréchal Niel	*Wm. Allen Richardson

Chinese or Bengal.

Cramoisie Superieure	White Pet
Mrs. Bosanquet	Red Pet

Hybrid Tea-scented.

Camoens	*Reine Marie Henriette
*Cannes la Coquette	*Reine Olga de Wurtemberg
Longworth Rambler	
*Madame Alfred Carrièr	*Viscountess Folkestone
Marie Lavallée	

Climbing Tea.

*Bouquet d'Or	Gloire de Dijon
Emilie Dupuy	Madame Berard

Tea-scented.

*Anna Ollivier	Jules Finger
*Caroline Kuster	Madame Charles
Ethel Brownlow	*—— Chedane Guinoisseau
Francisca Kruger	
*Grace Darling	—— Falcot
*Hon. Edith Gifford	*—— Lambard
Innocente Pirola	*Marie Van Houtte
Jean Ducher	Perle des Jardins
—— Pernet	*Souvenir d'un Ami

—*The Garden.*

THE

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